Reference Manual

Allen-Bradley

PowerFlex 750-Series AC Drives

Catalog Numbers 20F, 20G, 21G

Allen-Bradley • Rockwell Software

Rockwell Automation

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence
	SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

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Appendix A

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Notes:

Overview

The purpose of this manual is to provide detailed information including operation, parameter descriptions, and programming.

Who Should Use This Manual

This manual is intended for qualified personnel. You must be able to program and operate Adjustable Frequency AC Drive devices. In addition, you must have an understanding of the parameter settings and functions.

What Is Not in This Manual

The purpose of this manual is to provide detailed drive information including operation, parameter descriptions and programming.

Additional Resources

The following table lists publications that provide information about PowerFlex 750-Series drives.

Resource	Description
PowerFlex 750-Series Drive Installation Instruction, 750-IN001	Provides the basic steps required to install a PowerFlex® 750-Series AC drive.
PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001	Provides detailed information on: • I/O, control, and feedback options • Parameters and programming • Faults, alarms, and troubleshooting
PowerFlex 750-Series AC Drives Technical Data, publication 750-TD001	Provides detailed information on: • Drive specifications • Option specifications • Fuse and circuit breaker ratings
PowerFlex 20-HIM-A6 / -C6S HIM (Human Interface Module) User Manual, publication 20HIM-UM001	Provides detailed information on HIM components, operation, features.
PowerFlex 750-Series AC Drives Hardware Service Manual - Frame 8 and Larger, publication 750-TG001	Provides detailed information on: • Preventive maintenance • Component testing • Hardware replacement procedures
PowerFlex 755 Drive Embedded EtherNet/IP Adapter User Manual, publication 750COM-UM001	These publications provide detailed information on configuring, using, and troubleshooting PowerFlex 750-Series communication option modules and adapters.
PowerFlex 750-Series Drive DeviceNet Option Module User Manual, publication 750COM-UM002	
PowerFlex 7-Class Network Communication Adapter User Manuals, publications 750COM-UMxxx	

Resource	Description
PowerFlex 750-Series Safe Torque Off User Manual, publication 750-UM002	These publications provide detailed information on installation, set up, and operation of the 750-Series safety option modules.
Safe Speed Monitor Option Module for PowerFlex 750-Series AC Drives Safety Reference Manual, publication 750-RM001	
Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives, publication DRIVES-IN001	Provides basic information needed to properly wire and ground PWM AC drives.
PowerFlex AC Drives in Common Bus Configurations, publication DRIVES-AT002	Provides basic information needed to properly wire and ground PWM AC drives using a common bus.
Safety Guidelines for the Application, Installation and Maintenance of Solid State Control, publication SGI-1.1	Provides general guidelines for the application, installation, and maintenance of solid-state control.
A Global Reference Guide for Reading Schematic Diagrams, publication 100-2.10	Provides a simple cross-reference of common schematic/ wiring diagram symbols used throughout various parts of the world.
Guarding Against Electrostatic Damage, publication 8000-4.5.2	Provides practices for guarding against Electrostatic damage (ESD)
Product Certifications website, http://ab.com	Provides declarations of conformity, certificates, and other certification details.

The following publications provide necessary information when applying the Logix Processors.

Resource	Description
Logix5000 Controllers Common Procedures, publication 1756-PM001	This publication links to a collection of programming manuals that describe how you can use procedures that are common to all Logix5000 controller projects.
Logix5000 Controllers General Instructions, publication 1756-RM003	Provides a programmer with details about each available instruction for a Logix-based controller.
Logix5000 Controllers Process Control and Drives Instructions, publication 1756-RM006	Provides a programmer with details about each available instruction for a Logix-based controller.

The following publications provide information that is useful when planning and installing communication networks.

Resource	Description
ControlNet Coax Tap Installation Instructions, publication 1786-5.7	Provides procedures and specifications for the installation of ControlNet coaxial taps.
ControlNet Fiber Media Planning and Installation Guide, publication CNET-IN001	Provides basic information for fiber cable planning and installation.

You can view or download publications at http://www.rockwellautomation.com/literature. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Allen-Bradley Drives Technical Support

Use one of the following methods to contact Automation and Control Technical Support.

Online	Email	Telephone
www.ab.com/support/abdrives	support@drives.ra.rockwell.com	262-512-8176

Title	Online
Rockwell Automation Technical Support	http://support.rockwellautomation.com/knowledgebase

Product Certification

Product Certifications and Declarations of Conformity are available on the internet at www.rockwellautomation.com/products/certification.

Manual Conventions

- In this manual we refer to PowerFlex 750-Series Adjustable Frequency AC Drives as: drive, PowerFlex 750, PowerFlex 750 drive or PowerFlex 750 AC drive.
- Specific drives within the PowerFlex 750-Series may be referred to as:
  - PowerFlex 753, PowerFlex 753 drive or PowerFlex 753 AC drive
  - PowerFlex 755, PowerFlex 755 drive or PowerFlex 755 AC drive
- To help differentiate parameter names and LCD display text from other text, the following conventions will be used:
  - Parameter Names will appear in [brackets] after the Parameter Number. For example: P308 [Direction Mode].
  - Display text will appear in “quotes.” For example: “Enabled.”
- The following words are used throughout the manual to describe an action.

Word	Meaning
Can	Possible, able to do something
Cannot	Not possible, not able to do something
May	Permitted, allowed
Must	Unavoidable, you must do this
Shall	Required and necessary
Should	Recommended
Should Not	Not recommended

General Precautions

Qualified Personnel

ATTENTION: Only qualified personnel familiar with adjustable frequency AC drives and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

Personal Safety

ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage at the Power Terminal Block by measuring between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

Hazard of personal injury or equipment damage exists when using bipolar input sources. Noise and drift in sensitive input circuits can cause unpredictable changes in motor speed and direction. Use speed command parameters to help reduce input source sensitivity.

Risk of injury or equipment damage exists. DPI or SCANport™ host products must not be directly connected together via 1202 cables. Unpredictable behavior can result if two or more devices are connected in this manner.

The drive start/stop/enable control circuitry includes solid state components. If hazards due to accidental contact with moving machinery or unintentional flow of liquid, gas or solids exists, an additional hardwired stop circuit may be required to remove the AC line to the drive. An auxiliary braking method may be required.

Hazard of personal injury or equipment damage due to unexpected machine operation exists if the drive is configured to automatically issue a Start or Run command. Do not use these functions without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Product Safety

ATTENTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Wiring or application errors such as under sizing the motor, incorrect or inadequate AC supply, or excessive surrounding air temperatures may result in malfunction of the system.

This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

Configuring an analog input for 0-20 mA operation and driving it from a voltage source could cause component damage. Verify proper configuration prior to applying input signals.

A contactor or other device that routinely disconnects and reapplies the AC line to the drive to start and stop the motor can cause drive hardware damage. The drive is designed to use control input signals that will start and stop the motor. If an input device is used, operation must not exceed one cycle per minute or drive damage will occur.

Drive must not be installed in an area where the ambient atmosphere contains volatile or corrosive gas, vapors or dust. If the drive is not going to be installed for a period of time, it must be stored in an area where it will not be exposed to a corrosive atmosphere.

Class 1 LED Product

ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into module ports or fiber optic cable connectors.

Notes:

Drive Configuration

Accel/Decel Time

You can configure the drive's acceleration time and deceleration time.

Acceleration Time

P535[Accel Time 1] and P536 [Accel Time 2] set the acceleration rate for all speed changes. Defined as the time to accelerate from 0 to motor nameplate frequency P27 [Motor NP Hertz] or to motor nameplate rated speed P28 [Motor NP RPM]. The setting of Hertz or RPM is programmed in P300 [Speed Units]. Selection between Acceleration Time 1 and Acceleration Time 2 is controlled by a digital input function (see Digin Functions in the PowerFlex 750-Series Programming Manual, publication 750-PM001) or by Logic Command (sent over a communication network or DeviceLogix™ software).

Adjustment range is 0.00 to 3600.00 seconds.

Deceleration Time

P537 [Decel Time 1] and P538 [Decel Time 2] set the deceleration rate for all speed changes. Defined as the time to decelerate from motor nameplate frequency P27 [Motor NP Hertz] or from motor nameplate rated speed P28 [Motor NP RPM] to 0. The setting of Hertz or RPM is programmed in P300 [Speed Units]. Selection between Deceleration Time 1 and Deceleration Time 2 is controlled by a digital input function (see Digin Functions in the PowerFlex 750 series Programming Manual 750-PM001-EN-P) or by Logic Command (sent over a communication network or DeviceLogix software).

Adjustment range is 0.00 to 3600.00 seconds.

Auto Restart

The Auto Restart feature provides the ability for the drive to automatically perform a fault reset followed by a start attempt without user or application intervention. Provided the drive has been programmed with a 2 wire control scheme and the Run signal is maintained. This allows remote or unattended operation. Only certain faults are allowed to be reset. Faults listed as Non-Resettable in the programming manual indicate possible drive component malfunction and are not resettable.

Caution should be used when enabling this feature, because the drive will attempt to issue its own start command based on user selected programming.

Configuration

Setting P348 [Auto Rstrt Tries] to a value greater than zero will enable the Auto Restart feature. Setting the number of tries equal to zero will disable the feature.

ATTENTION: Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

P349 [Auto Rstrt Delay] sets the time, in seconds, between each reset/run attempt.

The auto reset/run feature supports the following status information:

- P936 [Drive Status 2] Bit 1 "AuRstrCntDwn" Provides indication that an Auto Restart attempt is presently counting down and the drive will attempt to start at the end of the timing event.
- P936 [Drive Status 2] Bit 0 "AutoRstr Act" Indicates that the auto restart has been activated.

Operation

The typical steps performed in an Auto Reset/Run cycle are as follows.

1. The drive is running and an Auto Reset Run fault occurs, thus initiating the fault action of the drive.
2. After the number of seconds in P349 [Auto Rstrt Delay], the drive will automatically perform an internal Fault Reset, resetting the faulted condition.
3. The drive will then issue an internal Start command to start the drive.
4. If another Auto Reset Run fault occurs the cycle will repeat itself up to the number of attempts set in P348 [Auto Rstrt Tries].
5. If the drive faults repeatedly for more than the number of attempts set in P348 [Auto Rstrt Tries] with less than five minutes between each fault, the auto reset/run is considered unsuccessful and the drive remains in the faulted state.
6. If the drive remains running for five minutes or more because the last reset/run without a fault, or is otherwise stopped or reset, the auto reset/run is considered successful. The Auto Restart status parameters are reset, and the process will repeat if another auto resettable fault occurs.

   See Aborting an Auto-Reset/Run Cycle for information on how the Reset/Run cycle can be aborted.

Beginning an Auto-Reset/Run Cycle

The following conditions must be met when a fault occurs for the drive to begin an auto reset/run cycle:

- The fault type must be Auto Reset Run.
- P348 [Auto Rstrt Tries] setting must be greater than zero.
- The drive must have been running, not jogging, not auto tuning, and not stopping, when the fault occurred. (A DC Brake state is part of a stop sequence and therefore is considered stopping.)

Aborting an Auto-Reset/Run Cycle

During an auto reset/run cycle the following actions/conditions will abort the reset/run attempt process:

- A stop command is issued from any source. (Removal of a 2-wire run-fwd or run-rev command is considered a stop assertion.)
- A fault reset command is issued from any source.
- The enable input signal is removed.
- P348 [Auto Rstrt Tries] is set to zero.
- A Non-Resettable fault occurs.
- Power to the drive is removed.
- The Auto Reset/Run Cycle is exhausted.

After all [Auto Rstrt Tries] have been made and the drive has not successfully restarted and remained running for five minutes or more, the auto reset/run cycle will be considered exhausted and therefore unsuccessful. In this case the auto reset/run cycle will terminate and an F33 “AuRsts Exhaust” fault will be indicated by P953 [Fault Status B] Bit 13 “AuRstExhaust.”

Auto/Manual

The purpose of the Auto/Manual function is to permit temporary override of speed control and/or exclusive ownership of logic (start, run, direction) control. A manual request can come from any port, including HIM, digital input or other input module. However, only one port may own manual control and must release the drive back to auto control before another port can be granted manual control. When in Manual mode, the drive will receive its speed reference from the port that requested manual control, unless otherwise directed by the Alternate Manual Reference Select.

The HIM can request Manual control by pressing the Controls key followed by the Manual key. Manual control is released by pressing the Controls key followed by Auto. When the HIM is granted manual control, the drive uses the speed reference in the HIM. If desired, the auto speed reference can be automatically preloaded into the HIM when entering HIM manual control, so that the transition is smooth.

Manual control can also be requested through a digital input. To do this, a digital input has to be set to request Manual control through P172 [DI Manual Control]. Digital Input Manual control requests can be configured to use their own alternative speed reference to control the drive. Digital inputs can also be used in conjunction with Hand-Off-Auto Start to create a 3 way HOA switch that incorporates Manual mode.

The Safe Speed Monitor Option Module uses Manual mode to control the speed of the drive when entering Safe Limited Speed monitoring.

Auto/Manual Masks

The port configuration of the Auto/Manual feature is performed through a set of masks. Together, these masks set which ports can control the speed and/or logic control of the drive as well as which ports can request Manual control. The masks are configured by setting a 1 or 0 in the bit number that corresponds to the port (Bit 1 for port 1, Bit 2 for port 2, and so forth). Digital Inputs are always configured through Bit 0, regardless of what port the module physically resides in. If both [Manual Ref Mask] and [Manual Cmd Mask] for a particular port are set to 0, that port will be unable to request manual control.

P324 [Logix Mask]
Logic Mask enables and disables the ports from issuing logic commands (such as start and direction) in any mode. Stop commands from any port are not masked and will still stop the drive.

P325 [Auto Mask]
Auto Mask enables and disables the ports from issuing logic commands (such as start and direction) while in Auto mode. Stop commands from any port are not masked and will still stop the drive.

P326 [Manual Comd Mask]
Manual Command Mask enables and disables the ports from exclusively controlling logic commands (such as start and direction) while in Manual mode. If a port assumes Manual control, and the corresponding bit for the port in the [Manual Cmd Mask] is set, no other port will be able to issue logic commands. Stop commands from any port are not masked and will still stop the drive.

P327 [Manual Ref Mask]
Manual Reference Mask enables and disables the ports from controlling the speed reference while in Manual mode. If a port assumes manual control, and the

corresponding bit for the port in the [Manual Ref Mask] is set, the drive will be commanded to the speed reference from that port. An alternate speed reference can be commanded using P328 [Alt Man Ref Sel]. If the respective bit for the manual control port is not set, then the drive will follow its normal automatic speed reference, even in Manual mode.

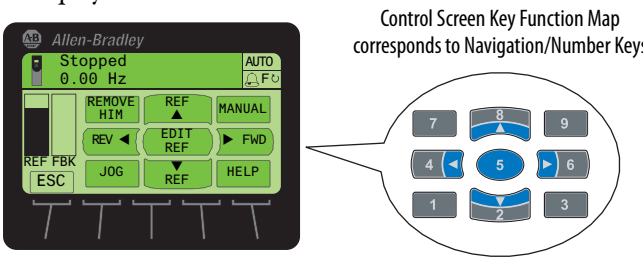
Alternate Manual Reference Select

By default, the speed reference used in Manual mode comes from the port that requested manual control (For example if a HIM in port 1 requests manual control, the speed reference in Manual mode will come from port 1). If instead it is desired to use an a different speed reference, P328 [Alt Man Ref Sel], can be used. The port selected in the parameter will be used for manual reference regardless of which port requested manual control, as long as the port in manual control is allowed to set the manual reference per P327 [Manual Ref Mask]. If P328 [Alt Man Ref Sel] is an analog input, the maximum and minimum speeds can be configured through P329 [Alt Man Ref AnHi] and P330 [Alt Man Ref AnLo]. For analog input between the minimum and maximum, the drive will derive the speed from these parameters through linear interpolation.

The P328 [Alt Man Ref Sel] manual reference overrides all other manual speed references, including P563 [DI ManRef Sel].

HIM Control

Manual Control can be requested through an HIM device attached to port 1, 2, or 3. The proper bits must be set in the masks (P324 [Logic Mask], P326 [Manual Cmd Mask], and P327 [Manual Ref Mask]) for the port that the HIM is attached. To request control through the HIM, press the (Controls) key to display the Control screen.



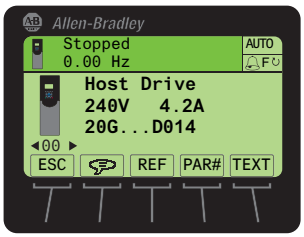
Press the 9 (Manual) key.

Press the 5 (Edit) key to confirm that you want to switch to Manual mode.

If the request is accepted, the HIM will show “MAN” in the top right corner. The display does not indicate if the drive is in Manual, but rather if that particular HIM has Manual control. A HIM will still read “AUTO” if it does not

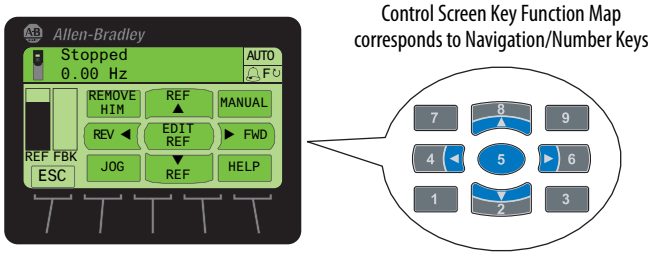
have ownership of the Manual mode, even if the drive itself is in Manual mode. To see if the drive is in Manual mode, check P935 [Drive Status] Bit 9.

When a HIM has Manual control of the drive, the drive will use the speed reference from the HIM unless overridden by P328 [Alt Man Ref Sel]. To change the speed reference on the HIM, navigate to the Status screen and press the middle soft key labeled REF.



If the request is not accepted, a message will appear indicating that "Manual Control is not permitted at this time." The most likely causes are that manual control is disabled for the port or that another port currently has manual control. To check which port has manual control, look at P924 [Manual Owner].

To release Manual mode from the HIM, press the (Controls) key to display the Control screen.



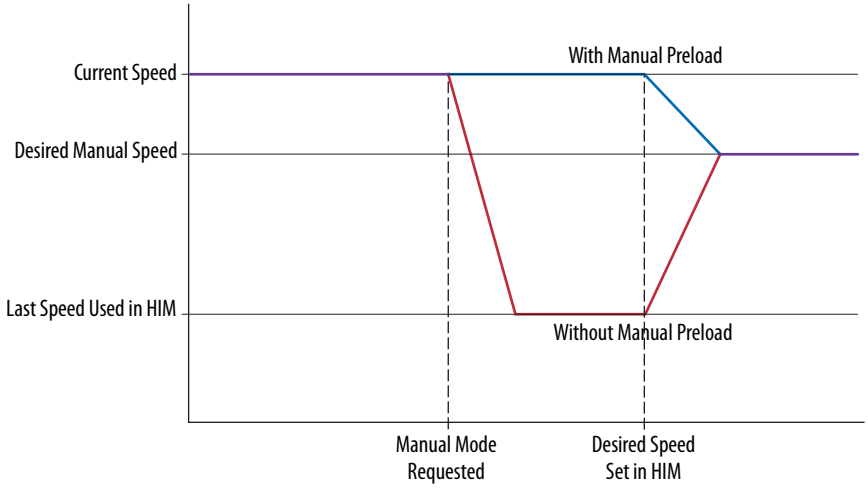
Press the 9 (Auto) key.

Press the 5 (Edit) key to confirm that you want to switch to Auto mode.

HIM Preload

Before taking a manual control speed reference from a HIM, the drive can preload its current speed into the HIM to provide a smooth transition. Without this feature, the drive would immediately transition to whatever speed was last used in the HIM, before the operator has a chance to make their adjustment.

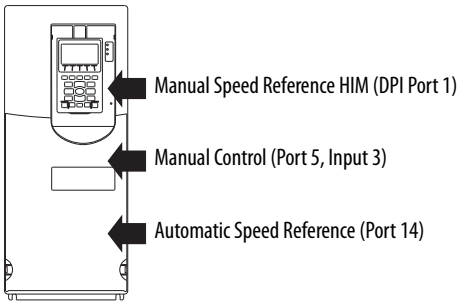
With this feature, the drive will maintain its current speed until the operator sets the speed to the desired manual reference.



The Auto/Manual HIM Preload is configured through P331 [Manual Preload]. Ports 1, 2, and 3 can be configured to have the speed reference preloaded into the HIM by setting bits 1, 2, and 3 respectively.

Example Scenario

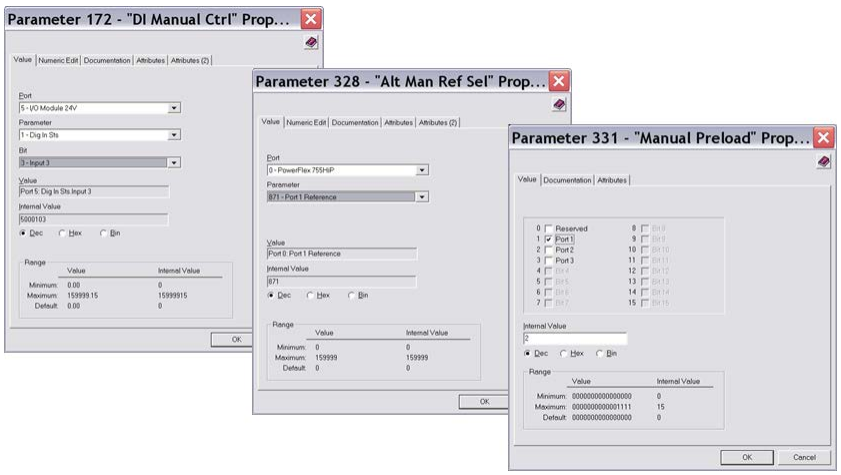
The drive has a HIM in port 1 and a 24V DC I/O module in port 5. You want to select manual control from a digital input 3 on the I/O module. You want the embedded EtherNet/IP port to be the source for the speed reference in Automatic mode, and the HIM to be the source for the speed reference in Manual mode.



Required Steps

1. Set P172 [DI Manual Ctrl] to Port 5-I/O Module > 1-Dig In Sts > 3 – Input 3.

2. Set P328 [Alt Man Ref Sel] = 871 Port 1 Reference 3. Set P331 [Manual Preload] = 0000 0000 0000 0010, Bit 1 enables the preloading of the speed feedback value to the HIM at port 1 when the HIM is granted manual control.



Digital Input Control

A Digital Input can be configured to request manual control through P172 [DI Manual Ctrl]. When setting up the Auto/Manual masks, digital inputs are configured through Bit 0, regardless of what port the module physically resides in.

A speed reference for Manual mode from a digital input can be set by selecting a port in P328 [Alt Man Ref Sel]. This however will cause all manual requests to use that port as a reference, whether the request was from the digital input or from a HIM. A separate manual reference port for use only when the request comes from a digital input can be configured through P563 [DI ManRef Sel]. (To see P564, set P301 [Access Level] to 1 "Advanced.") If P328 [Alt Man Ref Sel] is configured, it will override P563 [DI ManRef Sel] and will provide the manual reference.

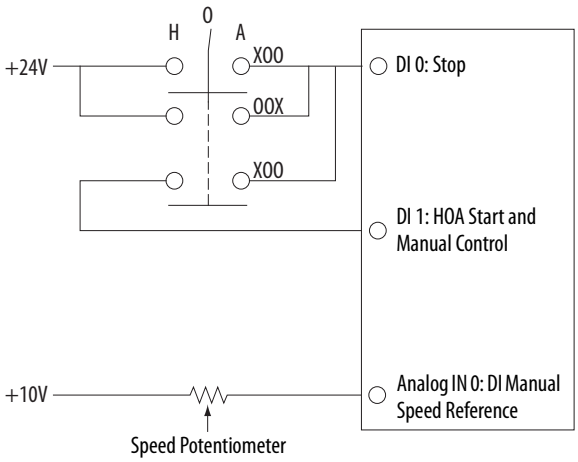
If P563 [DI ManRef Sel] is an analog input, the maximum and minimum speeds can be configured through P564 [DI ManRef AnlgHi] and P565 [DI ManRef AnlgLo]. For analog input between the minimum and maximum, the drive will derive the speed from these parameters through linear interpolation.

Hand-Off-Auto

The Auto/Manual feature can be used in conjunction with a Hand-Off-Auto Start to create a H-O-A switch that starts the drive and requests manual control at the same time, allowing for a local speed reference to control the drive. See Hand-Off-Auto on page 55 for more details on the Hand-Off-Auto Start feature.

In the circuit below, a speed potentiometer was added to the analog input to provide a speed reference to the drive. When the H-O-A switch is moved from Auto to Hand, the digital input block will request manual control and issue a start command to the drive. If the digital input port receives manual control, the drive will accelerate to the reference speed from the analog input. All attempts to change the speed except from the analog input will be blocked. If the drive is stopped while in Hand, switch the H-O-A switch to Off and then back to Hand to restart the drive.

If another port has manual control of the drive, but does not have exclusive ownership of the logic commands (due to P326 [Manual Cmd Mask]), turning the switch to Hand will cause the drive to begin moving but for the analog input to have no control over the speed.



For this circuit, set the following parameters (P301 [Access Level] must be set to 1 "Advanced" to see P563 [DI ManRef Sel]).

Number	Parameter Name	Value
158	DI Stop	Digital Input 0
172	DI Manual Control	Digital Input 1
176	DI HOA Start	Digital Input 1
324	Logic Mask	xxxxxxxxxxxxxx1 (Digital In)
326	Manual Cmd Mask	xxxxxxxxxxxxxx1 (Digital In)
327	Manual Ref Mask	xxxxxxxxxxxxxx1 (Digital In)
563	DI Manual Reference Select	Anlg In0 Value

The drive should now request Manual mode, start and track the reference speed coming from the Analog Input when the H-O-A switches to Hand. (The HIM will still read Auto. This display changes only when the HIM has control of Manual mode).

Safe Limited Speed

Safe Limited Speed through the PowerFlex Safe Speed Monitor Option Module uses Manual mode to control the speed of the drive. When Safe Limited Speed monitoring is enabled, the safety module requests manual control of the drive. If the drive does not reach a safe speed, as defined on the option module by P55 [Safe Speed Limit] and within P53 [LimSpd Mon Delay], the drive will fault.

While the option module uses the Manual mode, it has no way to provide a speed reference or start the drive. The following parameters must thus be configured.

P326 [Manual Cmd Mask]
Turn off the bit corresponding to the safety option's port to allow modules installed in other ports to continue to control the drive when it is operating in Manual mode. For example, if the safety option is installed in port 6, then turn off Bit 6 in this parameter.

P327 [Manual Ref Mask]
Turn on the bit corresponding to the safety option's port to allow the safety option to command the drive to use its Manual Speed Reference when it is operating in Manual mode. For example, if the safety option is installed in port 6, then turn on Bit 6 in this parameter.

P328 [Alt Man Ref Sel]
Set this parameter to select the desired speed reference when the drive is operating in Manual mode. For example, set this parameter to the value Port 0: Preset Speed 1 to configure the drive to use its P571 [Preset Speed 1] parameter as the Manual Speed Reference. In this case, the drive's P571 [Preset Speed 1] parameter must be less than the P55 [Safe Speed Limit] parameter in the safety option to avoid causing an SLS Speed Fault.

See the Safe Speed Monitor Option Module for PowerFlex 750-Series AAC Drives Safety Reference Manual, publication 750-RM001, for more information.

Automatic Device Configuration

Automatic Device Configuration (ADC) is a RSLogix™ 5000 software, version 20 or later, feature that supports the automatic download of configuration data upon the Logix controller establishing an EtherNet/IP network connection to a PowerFlex 755 drive (firmware 4.001 or later) and its associated peripherals.

A RSLogix 5000 software, version 16 or later, project (*.adc file) contains the configuration settings for any PowerFlex drives in the project. When the project is downloaded to the Logix controller, these settings are also transferred and reside in the controller's memory. Prior to ADC in RSLogix 5000 software version 20, downloading PowerFlex 755 configuration data was a manual process where you would open the Drive tab in the respective Drive Add-On Profile (AOP) in RSLogix 5000 and click the Download icon. ADC in RSLogix 5000software version 20 now automates this process.

ADC can also work in tandem with Firmware Supervisor. If Firmware Supervisor is set up and enabled for a drive (Exact Match keying must be used), the drive/peripheral will be automatically upgraded (if necessary) prior to any ADC operation for that port.

Information on Automatic Device Configuration (ADC) can be found in the PowerFlex 755 Embedded EtherNet/IP Adapter User Manual, publication 750COM-UM001, Chapter 4, Configuring the I/O includes the following topics:

- Description of the ADC functionality
- How the Drive Add-On Profiles (AOPs) affect ADC
- Configuring a PowerFlex 755 Drive (firmware 4.001 or later) for ADC
- ADC and Logix Memory
- Storing the Drive's and Peripherals' Firmware in the Logix Controller (Firmware Supervisor)
- Special Considerations When Using a DeviceLogix software Program
- Special Considerations When Using a 20-750-S1 Safe Speed Monitor Module
- Monitoring the ADC Progress
- Examples of potential issues and solutions

Autotune

The Autotune feature is used to measure motor characteristics. The Autotune feature is made up of several individual tests, each of which is intended to identify one or more motor parameters. These tests require motor nameplate information to be entered into the drive parameters. Although some of the parameter values can be changed manually, the best performance of the drive will be with measured values of the motors parameters. Each motor control mode requires its own set of tests to be performed. The information obtained from these measurements is stored in the drives non volatile memory for use during operation of the drive. The feature allows these tests to be separated into tests that don't require motor rotation (Static Tune), all tests within the selected control mode (Rotate Tune), or if the control mode requires the Inertia (Inertia Tune).

The Autotune tests are selected through the P70 [Autotune]. The feature provides a manual or automatic method for setting P73 [IR Voltage Drop], P74 [Ixo Voltage Drop] and P75 [Flux Current Ref]. Valid only when P35 [Motor Ctrl Mode] is set to 1 "Induction SV," 2 "Induct Econ," or 3 "Induction FV."

Other motor control modes such as Permanent Magnet and Interior Permanent magnet, populate other parameters associated with those control modes. See the autotune parameter set below.

Tests

Four Autotune selections will be available in the PowerFlex 755 drive control. All four selections are selected from the Autotune parameter.

P70 [Autotune]

- 0 = Ready
- 1 = Calculate
- 2 = Static Tune
- 3 = Rotate Tune
- 4 = Inertia Tune

Ready
Parameter returns to this setting following a Static Tune or Rotate Tune, at which time another start transition is required to operate the drive in Normal mode. It also permits manually setting P73 [IR Voltage Drop], P74 [Ixo Voltage Drop] and P75 [Flux Current Ref].

Calculate
When the Autotune parameter is set to Calculate (default), the drive uses motor nameplate data to automatically set P73 [IR Voltage Drop], P74 [Ixo Voltage Drop], P75 [Flux Current Ref] and P621 [Slip RPM @ FLA].

IR Volt Drop, PM IR Volt Drop, Encdrlss VoltComp, the IXo Volt Drop, the Flux Current, the PM DirTest Curr and the Slip Frequency parameters are updated based on nameplate parameter values. When a nameplate parameter

value is changed, the Autotune parameters are updated based on the new nameplate values.

When using Calculate, updated values come from a lookup table.

Static Tune
When the Autotune parameter is set to Static, only tests that do not create motor movement are run. A temporary command that initiates a non-rotational motor stator resistance test for the best possible automatic setting of P73 [IR Voltage Drop] in all valid modes and a non-rotational motor leakage inductance test for the best possible automatic setting of P74 [Ixo Voltage Drop] in a Flux Vector (FV) mode. A start command is required following initiation of this setting. Used when motor cannot be rotated.

Rotate Tune
The actual tests performed when Static and Rotate Tune selections are made, differ for the available motor control modes, Feedback Type and motor type selected. The tests performed are dependent on the settings of parameters [Motor Cntl Mode], [Pri Vel Fdbk Sel] and [Autotune]. The parameters that are updated are then dependent on the tests run and in some cases calculated values for some parameters will be used to update other parameters. Refer to Table 1.

A temporary command initiates a Static Tune and is then followed by a rotational test for the best possible automatic setting of P75 [Flux Current Ref]. In Flux Vector (FV) mode, with encoder feedback, a test for the best possible automatic setting of P621 [Slip RPM @ FLA] is also run. A start command is required following initiation of this setting.

IMPORTANT	If using rotate tune for a Sensorless Vector (SV) mode, the motor should be uncoupled from the load or results may not be valid. With a Flux Vector (FV) mode, either a coupled or uncoupled load will produce valid results. Caution must be used when connecting the load to the motor shaft and then performing an autotune. Rotation during the tune process may exceed machine limits.

Table 1 - Autotune Value Source

Control Mode	Motor Type	Feedback Select	Autotune	Rs	Xo	Idlt	Rslt	Id	Rsld	Slip	Encrls	Cemf	PmOffset
VF	Induction	NA	Static	ON	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF
			Dynamic	ON	OFF	OFF	OFF	ON	ON	OFF	OFF	OFF	OFF
	PM	NA	Static	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
			Dynamic	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
	Reluctance	NA	Static	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
			Dynamic	ON	OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF
FV	Induction	Encoder	Static	ON	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF
			Dynamic	ON	ON	OFF	OFF	ON	OFF	ON	OFF	OFF	OFF
		Encoderless	Static	ON	ON	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF
			Dynamic	ON	ON	ON	ON	ON	ON	OFF	ON	OFF	OFF
	PM	Encoder	Static	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
			Dynamic	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON
		Encoderless	Static	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
			Dynamic	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF
	Reluctance	Encoder	Static	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
			Dynamic	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
		Encoderless	Static	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
			Dynamic	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

Inertia Tune

The Inertia Autotune selection involves one test only. Several parameters are updated from the test results. Refer to the tables in the Individual Tests section.

A temporary command initiates an inertia test of the motor/load combination. The motor will ramp up and down while the drive measures the amount of inertia. This option applies only to FV modes selected in P35 [Motor Ctrl Mode]. Final test results should be obtained with load coupled to the motor as long as the rotation doesn't damage the machine.

Test Dependencies

When running the flux test, the selected accel rate is used unless it is less than 10 seconds. In this case, 10 seconds is forced. In the case of the Inertia test, a 0.1 second accel rate is used. The selected direction used during normal operation will be used for all rotation tests. Also, during any rotate test, the normal speed limits are enforced.

The thermal manager is always being run in the 2ms loop, which will provide protection during all of the Autotune tests.

Individual Tests

Some of the following tests are executed during an Autotune.

Resistance Test
This test will be a Static test whether Static or Rotate is selected. Used to measure Stator resistance.

Inductance Tests
This test will be a Static test whether Static or Rotate is selected. One test is used for Induction motors and a another is used for PM motors. The result from the Induction test is placed into the IX0 parameter and the PM test is placed into the IXd and IXq parameters.

Flux Test
This test will be a Rotate test that measures the current under a no load condition. The results are used for the flux current. If a Static test is used, the resulting value is from a lookup table.

Slip Test
This test will be a Rotate test that measures the difference between the rotor speed and the stator speed. This measurement is taken during acceleration.

PM Offset Test
This test may create a small amount of motor movement so will need to be performed with the Rotate selection. The test will read the encoder position when the drive outputs zero hertz.

Inertia Test
This test is a stand alone test that is used to measure the system inertia.

The drive sets this value in P76 [Total Inertia] as seconds of inertia. This reflects the time it takes to accelerate the load at 100% torque to base speed. This information can be very useful in determining the total inertia (in lb•ft^2) that is connected to a motor shaft.

Using the following formula, $Tacc = \frac{WK^2 \times \Delta N}{308(t)}$

and rearranging it to $WK^2 = \frac{Tacc \times 308 \times (t)}{\Delta N}$

we have a formula that isolates the connected inertia.

For the variables, Tacc is the 100% rating of the drive in lb•ft. Let's say I'm using a 10hp drive with a 10hp motor. We can rearrange the Horsepower formula below to solve for torque in lb•ft.

My motor is 10hp, 1785RPM, $HP = \frac{T \times Speed}{5252}$

and rearranging it to $T = \frac{HP \times 5252}{Speed}$

So let's plug in the numbers. $T = \frac{10 \times 5252}{1785}$ T = lb•ft

And (t) comes from what the drive reports as seconds of inertia after running the inertia tune. Let's say that the drive reported 2.12 seconds of inertia. And now organizing the variables we have

Tacc = 29.42
(t) = 2.12
N = 1785

plugging these into the formula, $WK^2 = \frac{Tacc \times 308 \times (t)}{\Delta N}$ $WK^2 = 10.76$

After these calculations, one can conclude that the connected inertia is equal to 10.76 lb•ft^2. Multiplying by 0.04214011 you get 0.453 kg•m^2.

You may wonder what effect P71 [Autotune Torque] may have on these calculations. Regardless of the value entered here the drive will interpolate as if this value was 100%. So the seconds of inertia that is reported by the drive will always reflect 100% torque.

CEMF Test
This is a Rotate test used to measure a PM motors CEMF.

Autotune Parameters Information about some other Autotune Parameters not covered above.

Autotune Parameters

P71 [Autotune Torque]
Typically the default value of 50% will be sufficient for most applications. You have the option of increasing this value or decreasing the value.

P73 [IR Voltage Drop]
The voltage drop due to resistance.

P74 [Ixo Voltage Drop]
The voltage drop due to Inductance.

P75 [Flux Current Ref]
The current necessary to flux up the motor. This value come from a lookup table for Static tunes and is measured during a Rotate tune. Obviously a rotate tune will give more accurate results.

P76 [Total Inertia]
Reported as seconds of inertia. See description above.

P77 [Inertia Test Lmt]
A number entered in this parameter will limit the inertia tune test to a maximum number of revolutions. If violated the drive will fault on Autotune Inertia Fault 144. Also when a value is entered and the drive determines that the number of revolutions will be exceeded it goes into a decel and stops before the value is exceeded.

P78 [Encdrlss AngComp] and **P79 [Encdrlss VltComp]**
These parameters are valid only for Flux Vector motor control mode and open loop. P78 is populated only by a rotate tune. P79 is populated by a Static measurement.

P80 [PM Cfg]
This configuration parameter allows certain tests to be performed based on the motor connected.

Permanent Magnet Motors

Parameters P81 through P93 and P120 are all populated by an autotune when the motor selected is permanent magnet. The value for these parameters are determined by a rotate tune only.

Interior Permanent Magnet Motors

Parameters P1630 through P1647 are all populated by an autotune when the motor selected is interior permanent magnet. The value for these parameters are determined by a rotate tune only.

Auxiliary Power Supply

The optional Auxiliary Power Supply module, 20-750-APS, is designed to provide power to a single drive's control circuitry in the event incoming supply power to the drive is removed or lost.

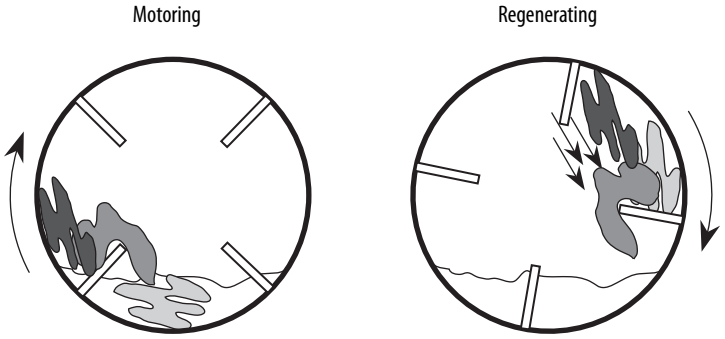
When connected to a user supplied 24V DC power source, the communication network functions remain operational and on-line. A DeviceNet program can also continue to run and control any associated input and outputs.

The auxiliary power supply module is designed to power all peripherals, I/O, and connected feedback devices.

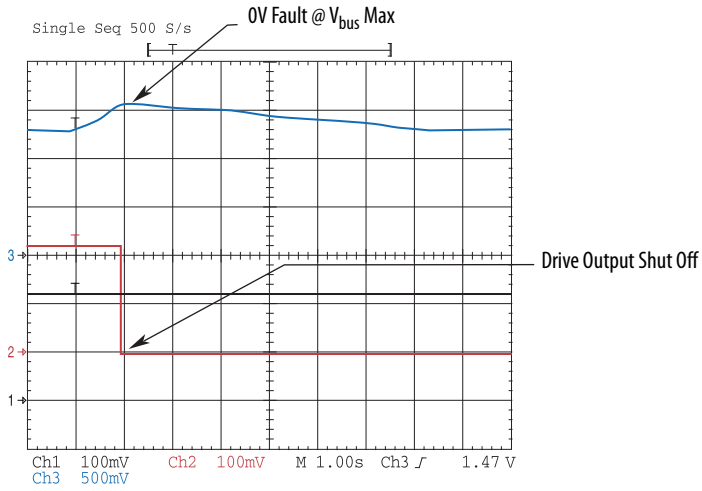
Bus Regulation

Some applications create an intermittent regeneration condition. The following example illustrates such a condition. The application is hide tanning, in which a drum is partially filled with tanning liquid and hides. When the hides are being lifted (on the left), motoring current exists. However, when the hides reach the top and fall onto a paddle, the motor regenerates power back to the drive, creating the potential for an overvoltage fault.

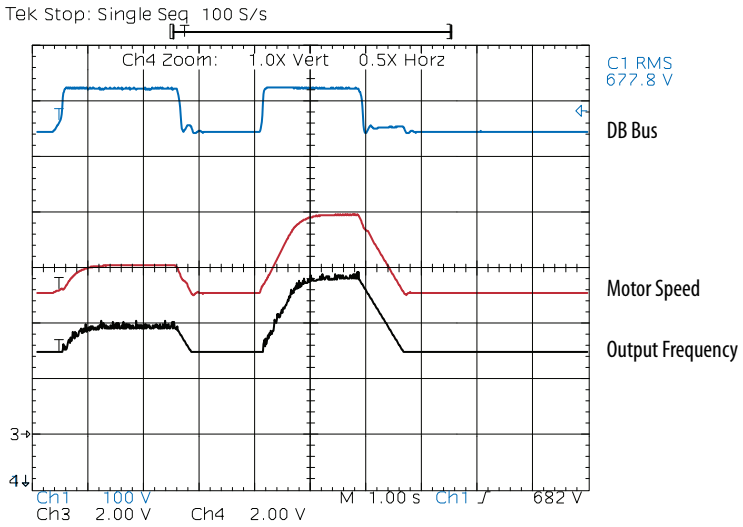
When an AC motor regenerates energy from the load, the drive DC bus voltage increases unless there is another means, of dissipating the energy, such as a dynamic braking chopper/resistor, or the drive takes some corrective action prior to the overvoltage fault value.



With bus regulation disabled, the bus voltage can exceed the operating limit and the drive will fault to protect itself from excess voltage.



With bus regulation enabled, the drive can respond to the increasing voltage by advancing the output frequency until the regeneration is counteracted. This keeps the bus voltage at a regulated level below the trip point.



The bus voltage regulator takes precedence over acceleration/deceleration.

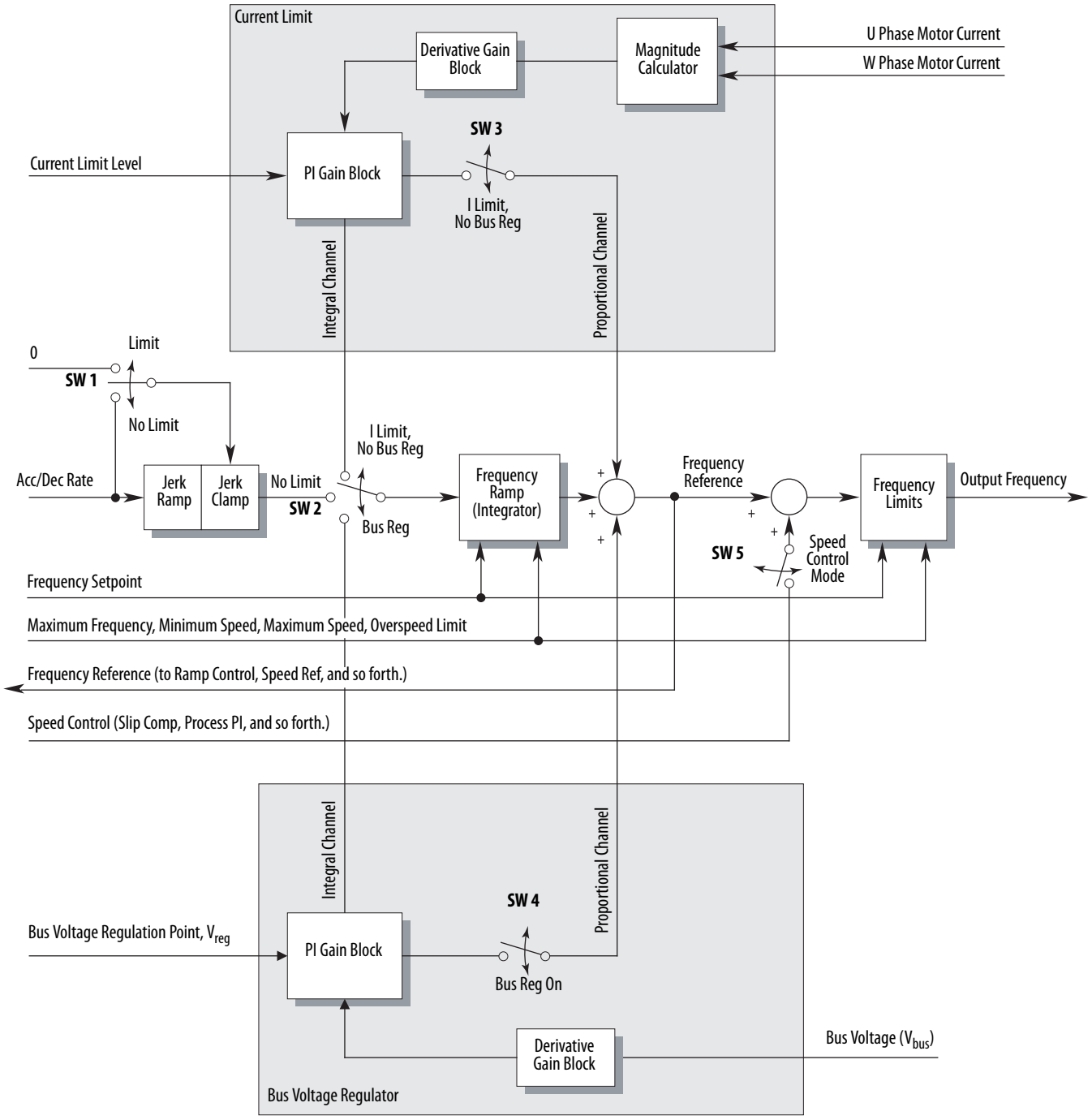
Select bus voltage regulation in the Bus Reg mode parameter.

Operation

Bus voltage regulation begins when the bus voltage exceeds the bus voltage regulation setpoint V_{reg} and the switches shown in Figure 1 move to the positions shown.

	SW 1	SW 2	SW 3	SW 4	SW 5
Bus Regulation	Limit	Bus Reg	Open	Closed	Don't Care

Figure 1 - Bus Voltage Regulator, Current Limit, and Frequency Ramp



The derivative term senses a rapid rise in the bus voltage and activates the bus regulator prior to actually reaching the bus voltage regulation setpoint V_{reg}. The derivative term is important since it minimizes overshoot in the bus voltage when bus regulation begins thereby attempting to avoid an over-voltage fault. The integral channel acts as the acceleration or deceleration rate and is fed to the frequency ramp integrator. The proportional term is added directly to the output of the frequency ramp integrator to form the output frequency. The output frequency is then limited to a maximum output frequency.

ATTENTION: The "adjust freq" portion of the bus regulator function is extremely useful for preventing nuisance overvoltage faults resulting from aggressive decelerations, overhauling loads, and eccentric loads. It forces the output frequency to be greater than commanded frequency while the drive's bus voltage is increasing towards levels that would otherwise cause a fault. However, it can also cause either of the following two conditions to occur.

1. Fast positive changes in input voltage (more than a 10% increase within 6 minutes) can cause uncommanded positive speed changes. However an "OverSpeed Limit" fault will occur if the speed reaches [Max Speed] + [Overspeed Limit]. If this condition is unacceptable, action should be taken to 1) limit supply voltages within the specification of the drive and, 2) limit fast positive input voltage changes to less than 10%. If this operation is unacceptable and the necessary actions cannot be taken, the "adjust freq" portion of the bus regulator function must be disabled (see parameters 161 and 162).

2. Actual deceleration times can be longer than commanded deceleration times. However, a "Decel Inhibit" fault is generated if the drive stops decelerating altogether. If this condition is unacceptable, the "adjust freq" portion of the bus regulator must be disabled (see parameters 161 and 162). In addition, installing a properly sized dynamic brake resistor will provide equal or better performance in most cases. **Important**: These faults are not instantaneous. Test results have shown that they can take between 2…12 seconds to occur.

Bus Regulation Modes

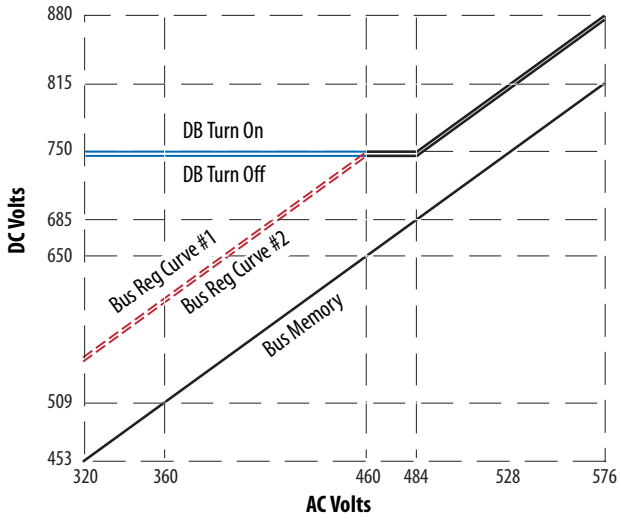
The drive can be programmed for one of five different modes to control the DC bus voltage:

- Disabled
- Adjust Frequency
- Dynamic Braking
- Both with Dynamic Braking first
- Both with Adjust Frequency first

P372 [Bus Reg Mode A] is the mode normally used by the drive unless the "DI BusReg Mode B" digital input function is used to switch between modes instantaneously, in which case P373[Bus Reg Mode B] becomes the active bus regulation mode.

The bus voltage regulation setpoint is determined from bus memory (a means to average DC bus over a period of time). The following tables and figure describe the operation.

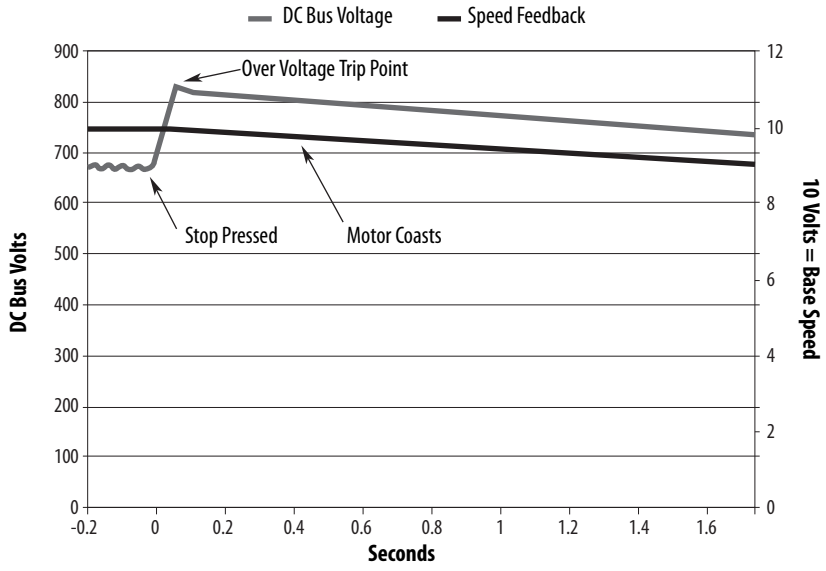
Voltage Class	DC Bus Memory	DB On Setpoint	DB Off Setpoint
480	<685V DC	750V DC	On - 8V DC
	>685V DC	Memory + 65V DC	



Option 0 "Disabled"

If [Bus Reg Mode *n*] is set to "Disabled" The Voltage Regulator is off and the DB transistor is disabled. Energy returning to the DC bus will increase the voltage unchecked and will trip the drive on over voltage once the voltage threshold is reached.

Figure 2 - PowerFlex 750-Series Bus Regulation – Disabled

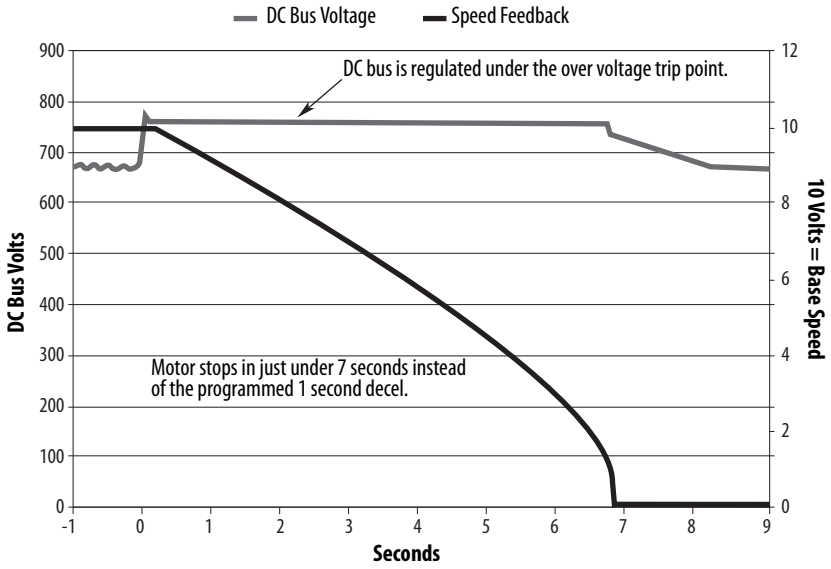


Option 1 "Adjust Freq"

If [Bus Reg Mode *n*] is set to "Adjust Freq" The Bus Voltage Regulator is enabled. The Bus Voltage Regulator setpoint follows "Bus Reg Curve 1" below a DC Bus Memory of 650V DC and follows the "DB Turn On" above a DC Bus Memory of 650V DC (Table 3). For example, with a DC Bus Memory at 684V DC, the adjust frequency setpoint is 750V DC.

Below you can see the DC bus is being regulated as the speed is sacrificed to be sure the drive does not trip on over voltage.

Figure 3 - PowerFlex 750-Series Bus Regulation – Adjust Frequency



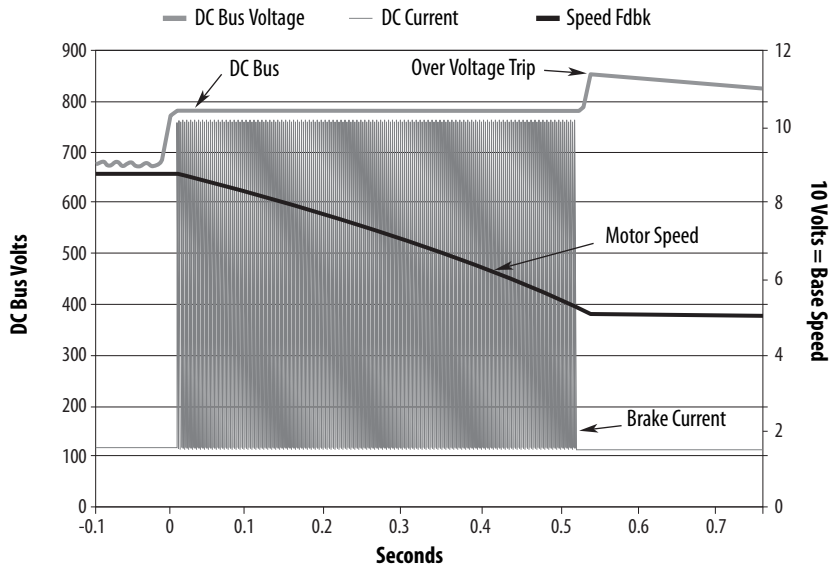
Option 2 "Dynamic Brak"

If [Bus Reg Mode *n*] is set to "Dynamic Brak" The Dynamic Brake Regulator is enabled. In Dynamic Brake mode the Bus Voltage Regulator is turned off. The "DB Turn On" and turn off curves apply. For example, with a DC Bus Memory at 684V DC, the Dynamic Brake Regulator will turn on at 750V DC and turn back off at 742V DC. The Dynamic Brake mode can operate differently depending upon the setting of P382 [DB Resistor Type] either External or Internal.

Internal Resistor

If the drive is set up for an internal resistor, there is a protection scheme built into the firmware such that if it is determined that too much power has been dissipated into the resistor the firmware will not allow the DB transistor to fire any longer. Thus the bus voltage will rise and trip on over voltage.

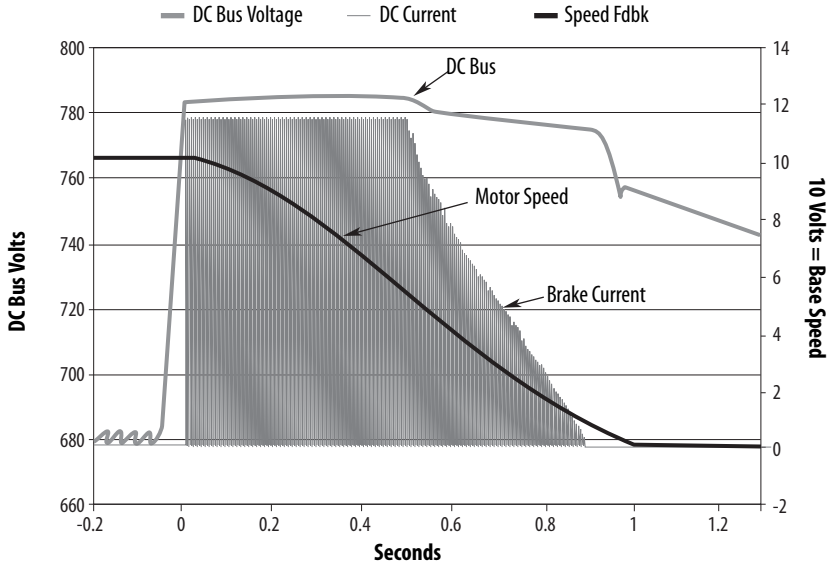
Figure 4 - PowerFlex 750-Series Bus Regulation – Internal Dynamic Brake Resistor



External Resistor

If the drive is set up for an external resistor and the resistor has been sized correctly and the regenerative power limit is set to a value that will allow the regenerative power to be fully dissipated, the DB transistor will continue to fire throughout the decel time.

Figure 5 - PowerFlex 750-Series Bus Regulation – External Dynamic Brake Resistor



The DB current seems as if it is decreasing toward the end of the decel. This is just a result of the sweep time of the o-scope and instrumentation. After all, it's not known as "Ohm's Suggestion." The point is evident that the DB transistor is pulsing through the decel.

Option 3 "Both DB 1st"

If [Bus Reg Mode *n*] is set to 3 "Both DB 1st" Both regulators are enabled, and the operating point of the Dynamic Brake Regulator is lower than that of the Bus Voltage Regulator. The Bus Voltage Regulator setpoint follows the "DB Turn On" curve. The Dynamic Brake Regulator follows the "DB Turn On" and turn off curves. For example, with a DC Bus Memory between 650 and 685V DC, the Bus Voltage Regulator setpoint is 750V DC and the Dynamic Brake Regulator will turn on at 742V DC and back off at 734V DC.

It is possible that the drive will react differently between Flux Vector mode and Sensorless Vector mode. The important thing to remember here is that in SV control, the drive does NOT use the value entered into P426 [Regen Power Lmt]. If left at default (-50%) and the decel is such that it creates a large amount of regen power, the drive will again attempt to protect the resistor.

Consider the plots below.

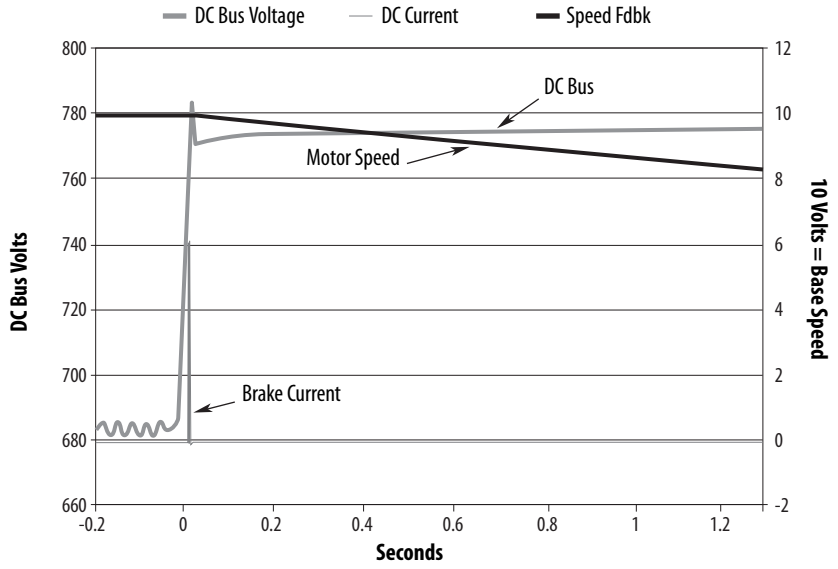
Option 4 "Both Frq 1st"

If [Bus Reg Mode *n*] is set to 4 "Both Frq 1st" Both regulators are enabled, and the operating point of the Bus Voltage Regulator is lower than that of the Dynamic Brake Regulator. The Bus Voltage Regulator setpoint follows the "Bus Reg Curve 2" below a DC Bus Memory of 650V DC and follows the "DB Turn Off" curve above a DC Bus Memory of 650V DC (Table 2). The Dynamic Brake Regulator follows the "DB Turn On" and turn off curves. For example, with a

DC Bus Memory at 684V DC, the Bus Voltage Regulator setpoint is 742V DC and the Dynamic Brake Regulator will turn on at 750V DC and back off at 742V DC.

Below shows that upon a stop command the bus voltage rises immediately to a point where the DB transistor turns on briefly bringing the voltage down to a point where the bus regulator can regulate the bus by adjusting the output frequency (speed).

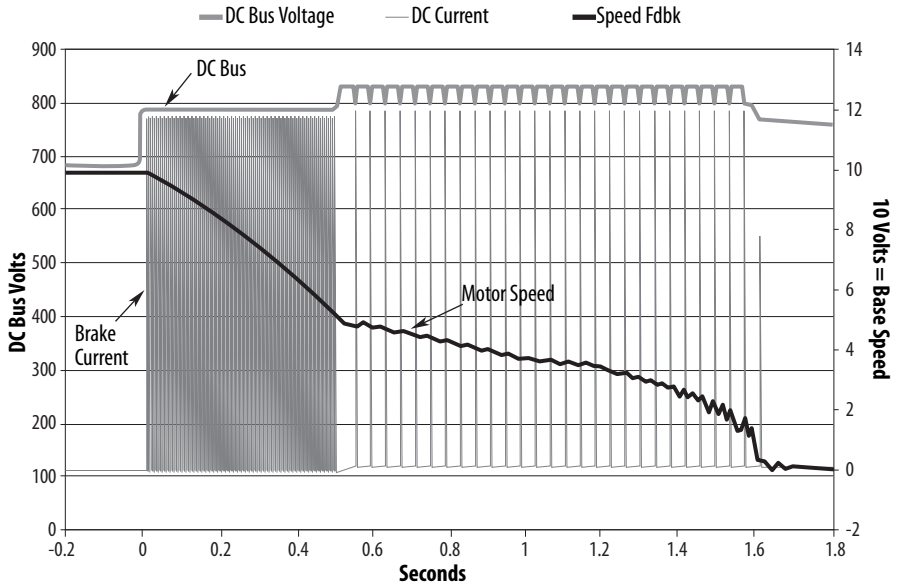
Figure 6 - PowerFlex 750-Series Bus Regulation – Both Adj First



Flux Vector (FV) Control

With the Regen Power Limit left at default, and a decel time of 0.1 seconds, the drive is limiting the amount of power to a point where the resistor could be heating up due to duty cycle considerations. So the drive stops the DB transistor from firing and switches to "Adjust Frequency" to regulate the bus and then allows another DB pulse and then back to adjust frequency and so on until the bus voltage remains below the trigger level.

Figure 7 - PowerFlex 750-Series Bus Regulation – Both DB First FV



If the Regen Power Limit is opened up to, say, 100% the plot would look exactly the same as the Sensorless Vector mode plot show below.

Sensorless Vector (SV) Control

Since the drive is not limiting the regen power the DB is able to dissipate the power the entire decel time before duty cycle considerations limits the DB capability.

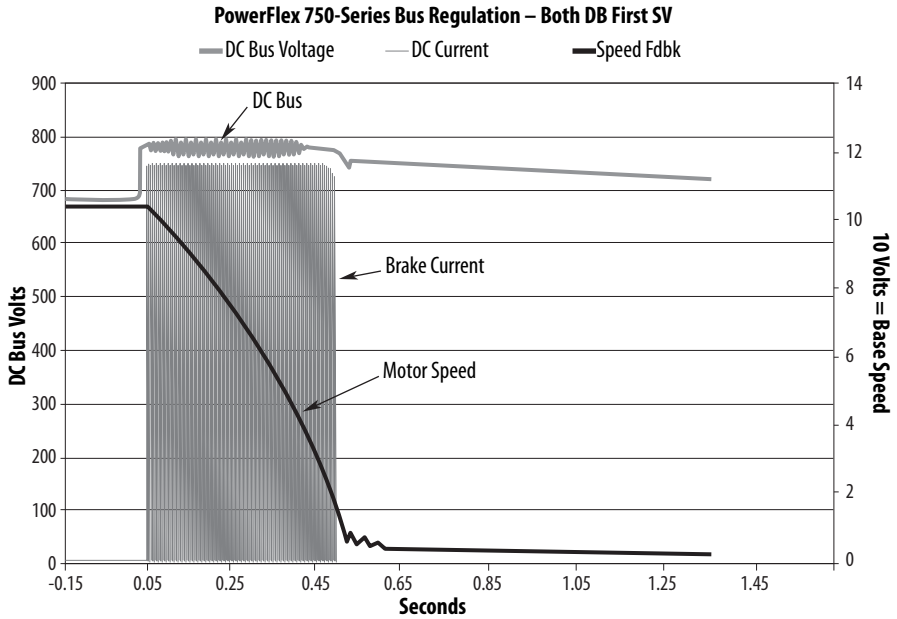


Table 2 - Bus Regulation Curves

Voltage Class	DC Bus Memory	Bus Reg Curve 1	Bus Reg Curve 2
480	< 650V DC	Memory + 100V DC	Curve 1 - 8V DC
	650V DC ≤ DC Bus Memory ≤ 685V DC	750V DC	
	> 685V DC	Memory + 65V DC	

Level/Gains

The following parameters are Level/Gains related to bus regulation.

P374 [Bus Reg Lvl Cfg]
Bus Regulation Level Configuration - Selects the reference used to determine the bus voltage regulation level for the bus voltage regulator and the reference used for the dynamic brake.

- "Bus Memory" (0) – References are determined based on P12 [DC Bus Memory].
- "BusReg Level" (1) – References are determined based on the voltage set in P375 [Bus Reg Level].

If coordinated operation of the dynamic brakes of a common bus system is desired, use this selection and set the P375 [Bus Reg Level] to coordinate the brake operation of the common bus drives.

P375 [Bus Reg Level]
Bus Regulation Level - Sets the turn-on bus voltage level for the bus voltage regulator and the dynamic brake.

Table 3 - Turn On Bus Voltage

P20 [Rated Volts] =	Default Turn On Volts =	Min/Max Setting =
< 252V	375V	375V / 389V
252…503V	750V	750 / 779V
504…629V	937V	937 / 974V
> 629V	1076V	1076 / 1118V

While the following parameters are listed and editable in the drive, they typically do not need to be adjusted in any way. Care should taken when adjusting since undesired operation may occur in another aspect of motor control.

P376 [Bus Limit Kp]
Bus Limit Proportional Gain - Allows for a progressively faster decel when the drive is behind the programmed decel time by making the bus limiter more responsive. A higher value means the drive will try to decrease decel time.
This parameter is valid only in NON-Flux Vector modes.

P377 [Bus Limit Kd]
Bus Limit Derivative Gain - Lets you force the bus limit sooner. The higher the value the quicker the bus limit will be hit and regulation starts. May actually

regulate below the typical setpoint (750VDC for 460V drive). Too high a value and normal operation of the motor may be affected. (60...60.5 Hz oscillation.)
This parameter is valid only in NON-Flux Vector modes.

P378 [Bus Limit ACR Ki]
Bus Limit Active Current Regulator Integral Gain - If you find your system makes the regulator unstable or oscillatory, a lower value in this parameter will settle out the oscillations
This parameter is valid only in NON-Flux Vector modes.

P379 [Bus Limit ACR Kp]
Bus Limit Active Current Regulator Proportional Gain - Determines the responsiveness of the active current and therefore, regenerated power and bus voltage. Raising this value can cause the output frequency (when in bus limit) to become noisy or jittery. Too low a value can cause the bus limit function to malfunction and result in a over voltage fault.
This parameter is valid only in NON-Flux Vector modes.

P380 [Bus Reg Ki]
Bus Regulator Integral Gain - When regulating the DC bus the voltage tends to swing above and below the voltage setpoint in what may look like a ringing oscillation. This parameter affects that behavior. The lower the value the less oscillation should occur.
This parameter is valid only in Flux Vector modes.

P381 [Bus Reg Kp]
Bus Regulator Proportional Gain - This will determine how fast the bus regulator will activate. The higher the value the faster the drive will react once the DC voltage setpoint is reached.
This parameter is valid only in Flux Vector modes.

Once again, the likelihood of these parameters needing adjustment is highly unlikely. In fact, some descriptions related to the functionality of these parameters are intentionally left out of this text to eliminate undesired motor operation when they are adjusted unwisely.

Configurable Human Interface Module Removal

With the PowerFlex 750-Series the drives response to a HIM communication loss (removal) is configurable. This feature is available in drives with firmware revision 3.0 or later.

It is used to prevent unintended stopping of the drive by disconnecting the HIM. However, the HIM cannot be the sole source of a Stop command to enable this feature.

The configuration is similar to the communication adapter communication loss selections:

- 0 = Fault
- 1 = Stop
- 2 = Zero Data
- 3 = Hold Last
- 4 = Send Fault Config

The default setting is 0 “Fault.”

The HIM can be connected to one 1 of 3 ports per the parameters below. Each port is configured separately:

- P865 [DPI Pt1 Flt Actn] to determine the fault action at port 1.
- P866 [DPI Pt2 Flt Actn] to determine the fault action at port 2.
- P867 [DPI Pt3 Flt Actn] to determine the fault action at port 3.

If “Send Flt Cfg” is to be selected for the fault action, then configure the appropriate parameter below.

- P868 [DPI Pt1 Flt Ref] to set the speed reference if the HIM at port 1 is disconnected.
- P869 [DPI Pt2 Flt Ref] to set the speed reference if the HIM at port 2 is disconnected.
- P870 [DPI Pt3 Flt Ref] to set the speed reference if the HIM at port 3 is disconnected.

A constant value must be entered as the fault speed reference in this instance.

Duty Rating

Applications require different amounts of overload current.

Normal Duty: Sizing the drive for Normal Duty allows the use of the highest continuous output current rating of the drive and an overload rating of 110% for 60 seconds (every 10 minutes) and 150% for 3 seconds (every minute).

Heavy Duty: For heavy duty applications, a drive one size larger than is required for the motor is used in the application and therefore provides a larger amount of overload current in comparison to the motor rating. Heavy Duty sizing provides at least 150% for 60 seconds (every 10 minutes) and 180% for 3 seconds (every minute).

Light Duty: The Light Duty setting, for a given normal duty rated drive, provides a higher continuous output current but with limited overload capability. When in light duty, the drive will only allow for 110% for 60 seconds (every 10 minutes).

The overload percentages are with respect to the connected motor rating.

The duty rating is programmed in P306 [Duty Rating]. This parameter will be reset to the default setting if a Set Defaults "ALL" is executed. For drives rated under 7.5 kW (10 Hp) the normal duty and heavy duty continuous current ratings are the same, and will have the heavy duty overload settings.

When changing the [Duty Rating], parameters 422 [Current Limit 1] and 423 [Current Limit 2] should also be reviewed.

Refer to the PowerFlex 750-Series AC Drives Technical Data, publication 750-TD001, for continuous and overload current ratings for each catalog number.

Feedback Devices

There are three different feedback option modules available for PowerFlex 750-Series AC Drives:

- Single Incremental Encoder (20-750-ENC-1)
- Dual Incremental Encoder (20-750-DENC-1)
- Universal Feedback (20-750-UFB-1)

The Dual Incremental Encoder and Universal Feedback modules each support up to two encoders while the Single Incremental Encoder supports one encoder. Multiple feedback option modules can be installed in the drive, however there is a limit of two feedback modules if using Integrated Motion on EtherNet/IP.

For more information on the option modules, including specifications and wiring information, see the PowerFlex 750-Series AC Drives Installation Instructions, publication 750-IN001.

For more information on encoder feedback options, including connections and compatibility, see Appendix E of the PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001.

Flying Start

The Flying Start feature is used to start into a rotating motor, as quick as possible, and resume normal operation with a minimal impact on load or speed.

When a drive is started in its normal mode it initially applies a frequency of 0 Hz and ramps to the desired frequency. If the drive is started in this mode with the motor already spinning, large currents will be generated. An over current trip may result if the current limiter cannot react quickly enough. The likelihood of an over current trip is further increased if there is a residual flux (back emf) on the spinning motor when the drive starts. Even if the current limiter is fast enough to prevent an over current trip, it may take an unacceptable amount of time for synchronization to occur and for the motor to reach its desired frequency. In addition, larger mechanical stress is placed on the application.

In Flying Start mode, the drive's response to a start command is to synchronize with the motors speed (frequency and phase) and voltage. The motor will then accelerate to the commanded frequency. This process will prevent an over current trip and significantly reduce the time for the motor to reach its commanded frequency. Since the drive synchronizes with the motor at its rotating speed and ramps to the proper speed, little or no mechanical stress is present.

The Sweep function is currently not in the PowerFlex 750-Series drives frame 8 and larger.

Configuration

Flying Start can be configured by setting P356 [FlyingStart Mode] to the following:

- 0 “Disabled”
- 1 “Enhanced”
- 2 “Sweep”

Disabled
Disables the feature.

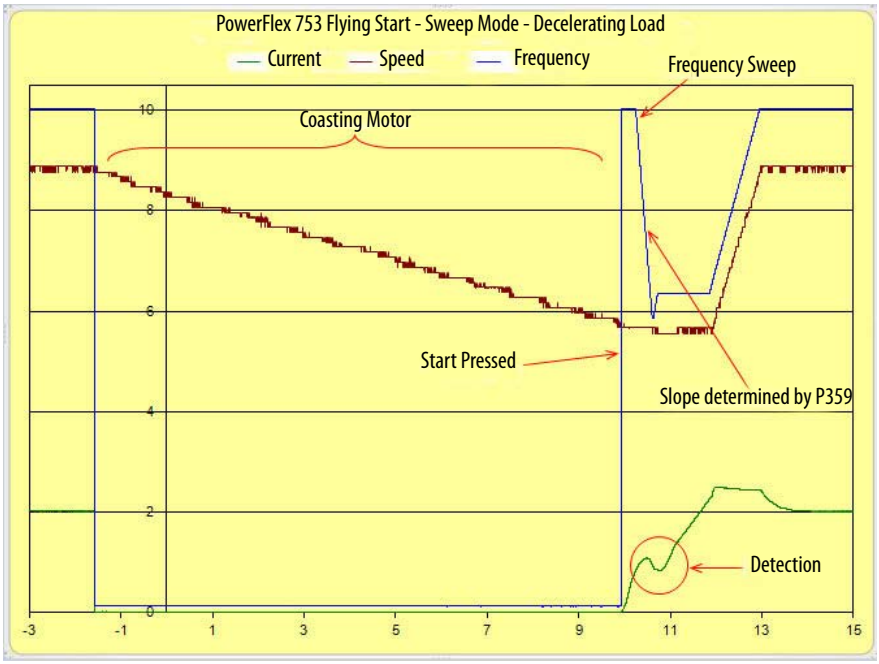
Enhanced
An advanced mode that performs the motor reconnect quickly by using the motor’s CEMF as a means of detection. This mode would be the typical setting for this feature.

Sweep
The Frequency Sweep mode is used with output sine wave filters. It attempts a reconnect by outputting a frequency starting at P520 [Max Fwd Speed]+ P524 [Overspeed Limit] and decreasing according to a slope that is modified by P359 [FS Speed Reg Ki] until there is a change in the monitored current indicating the speed of the spinning motor has been found. If the motor was not found from the forward sweep, the drive will sweep in the reverse direction from P521 [Max Rev Speed]+ P524 [Overspeed Limit].

Scope Plots

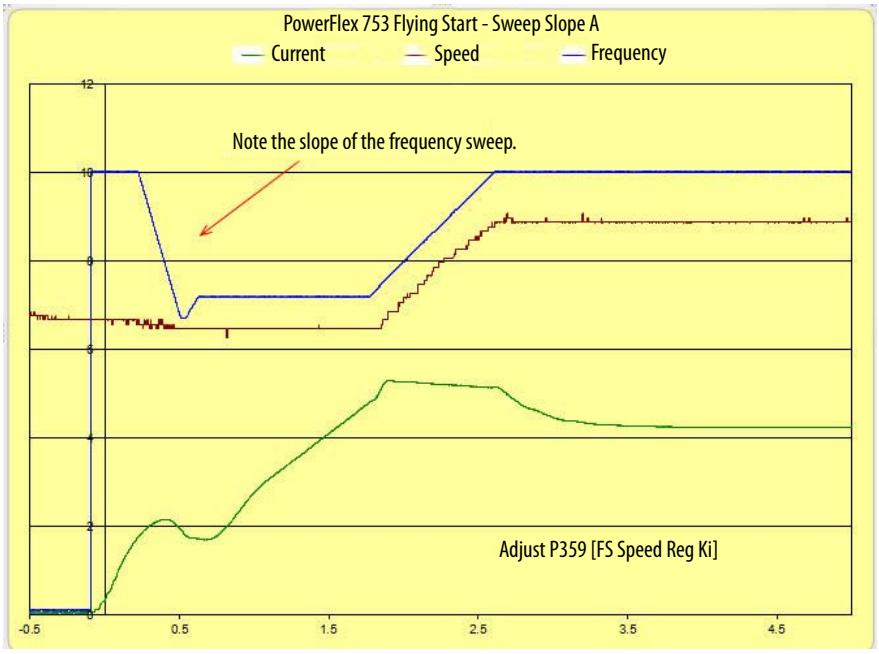
Flying Start - Sweep Mode

This plot shows a coasting motor. When a start is commanded, the output frequency jumps up to P520 [Max Fwd Speed]+ P524 [Overspeed Limit] at some current. As the sweep frequency decreases the current is monitored. When the sweep frequency matches the frequency of the coasting motor, the current reverses and detection is complete. The motor is accelerated back to commanded speed.



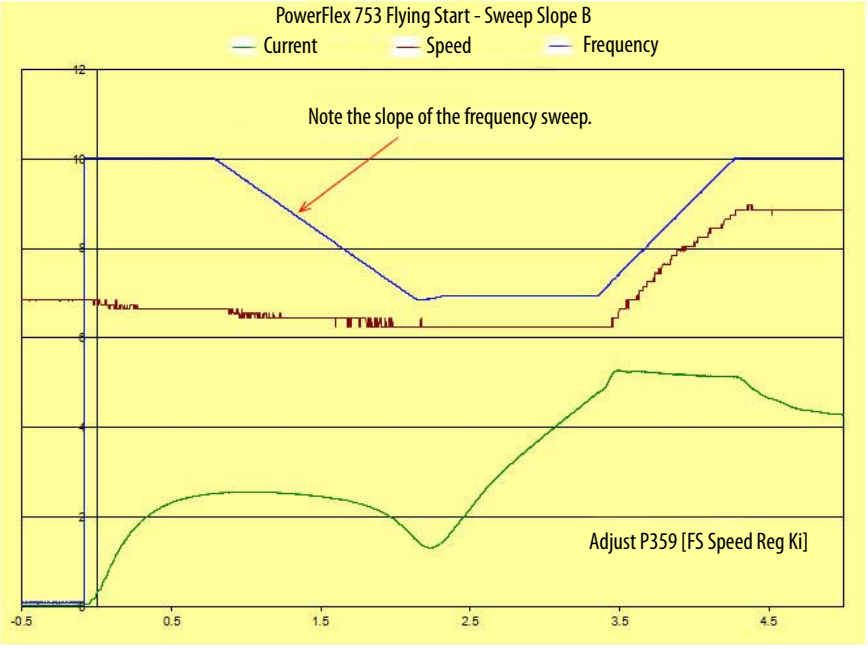
Flying Start - Sweep Slope A

This plot shows when the drive starts to sweep for the spinning motor, the frequency sweep has a certain slope associated with it. By modifying P359 [FS Speed Reg Ki] you can change the slope of this sweep.



Flying Start - Sweep Slope B

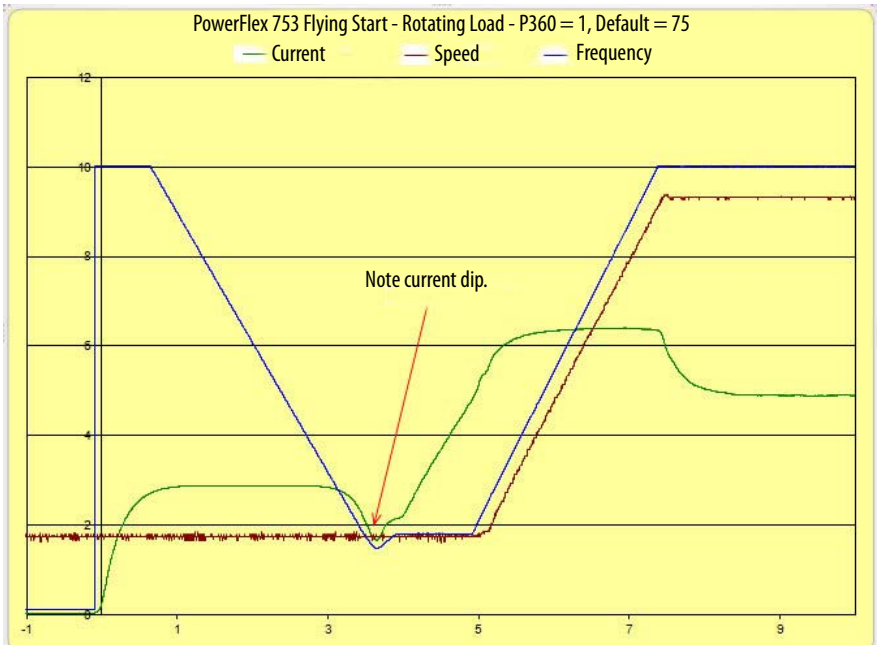
This plot shows the result of increasing P359 [FS Speed Reg Ki]. The slope is extended.



In the two samples shown above, the motor was decelerating. The sweep function and slope manipulation work the same if the motor was spinning at some constant speed.

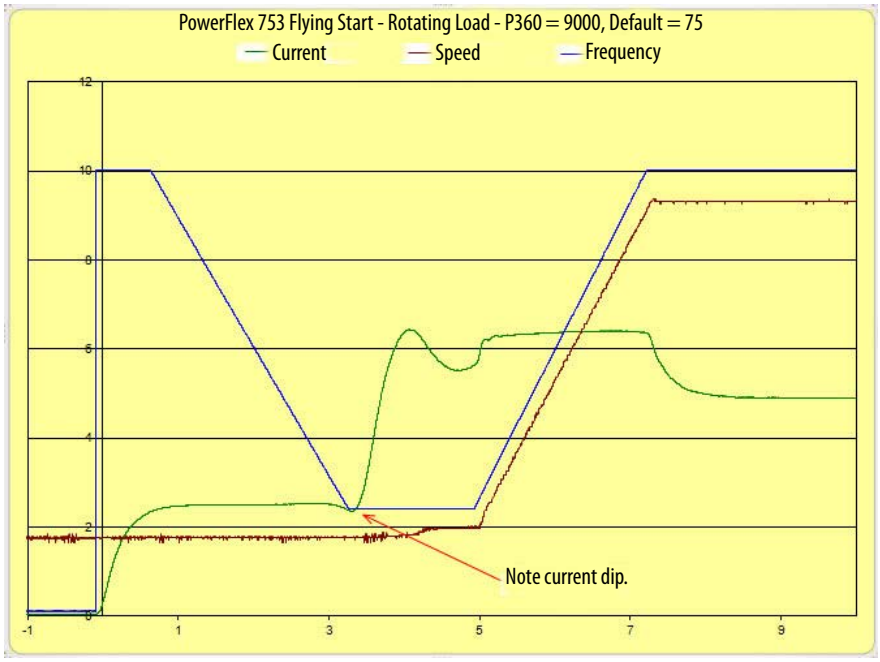
Flying Start - Sweep Dip A

This plot shows the effect of modifying P360 [FS Speed Reg Kp]. In this plot a motor is spinning at some constant speed when the drive is issued a start command and the sweep routine is started. Note the current dip when the parameter is set to it's lowest value and the drive has determined the frequency of the rotating motor. See the next plot when this parameter set to it's highest setting.



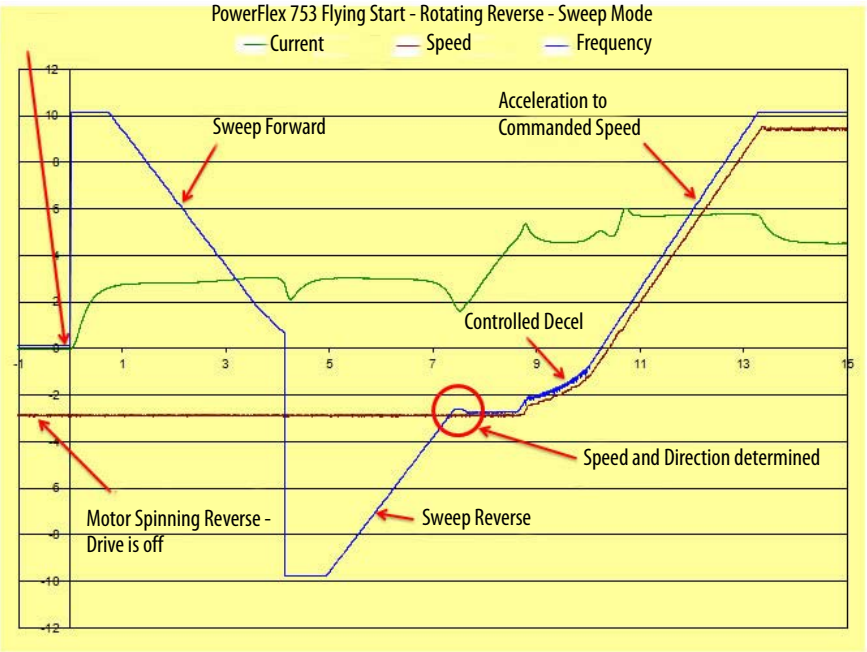
Flying Start - Sweep Dip B

This plot shows the effect of modifying P360 [FS Speed Reg Kp]. In this plot a motor that is spinning at some constant speed when the drive is issued a start command and the sweep routine is started. Note the current dip when the parameter is set to it's highest value and the drive has determined the frequency of the rotating motor. See the previous plot when this parameter set to it's lowest setting.



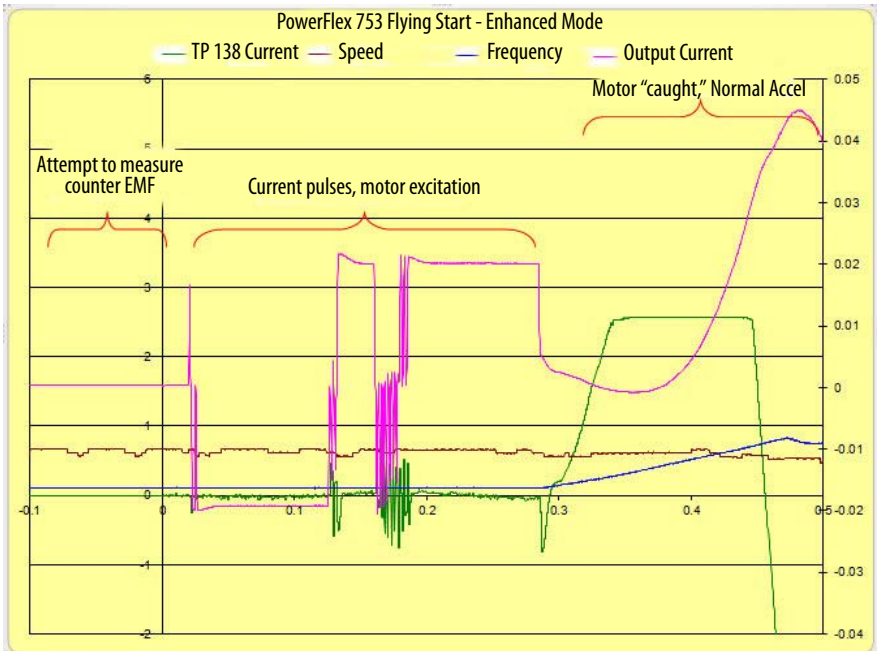
Flying Start - Sweep Reverse Rotating Motor

This plot shows the Sweep mode when the motor is rotating opposite from the commanded frequency. It starts the same as explained above. If it didn't detect the motor's speed as it reaches 3 Hz it begins to sweep in the opposite direction. From here the process continues the same as before.

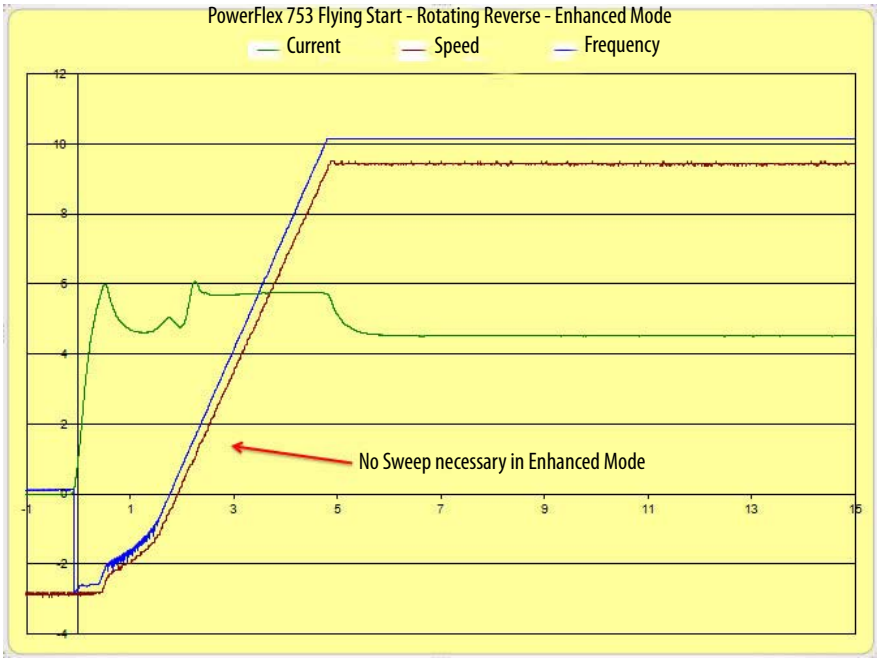


Flying Start - Enhanced Mode

This plot shows a very short time base of the Enhanced mode. If the drive detects the counter EMF of the motor it can instantly re-connect to the motor and accelerate to the commanded speed. If the drive cannot measure the CEMF (this is where the plot picks up) it will send current pulses to the motor in an attempt to excite the motor allowing the drive to detect the speed of the motor. This usually happens only at very low speeds. Once the drive has detected the motor it will accelerate to the commanded speed.



Flying Start - Enhanced Mode Reverse
Here is a motor spinning in the opposite direction of the commanded speed. In Enhanced mode the detection takes a very short time and the motor is controlled to zero speed and accelerated to the commanded speed.



P357 [FS Gain]
Sweep mode - The amount of time the detection signal (current) must be below the setpoint. A very short time entered could cause false detections. Too long of a time and detection could be missed.

Enhanced mode - It's the Kp in the current regulator used in the detection process. Used along with P358

P358 [FS Ki]
Sweep mode - Integral term in voltage recovery, indirectly connected to time; higher value may shorten recovery time but may cause unstable operation.

Enhanced mode - It's the Ki in the current regulator used in the detection process. Used along with P357.

P359 [FS Speed Reg Ki]
Sweep mode - The amount of time to sweep the frequency. A short time entered will produce a steep slope on the frequency. A higher value (longer time) will produce a flatter frequency sweep. Shown above.

Enhanced mode - It's the Ki in the speed regulator used in the detection process. Used along with P358.

P360 [FS Speed Reg Kp]
Sweep mode - Sets level the current must drop below. A larger value requires less change in current to indicate detection.

Enhanced mode - It's the Kp in the speed regulator used in the detection process. Used along with P357.

P361 [FS Excitation Ki]
Sweep mode - Integral term used to control the initial output voltage

Enhanced mode - Integral term used in the current regulator, which controls the motor excitation if the detection process deemed it necessary to excite the motor.

P362 [FS Excitation Kp]
Sweep mode - Proportional term used to control the initial output voltage

Enhanced mode - Proportional term used in the current regulator, which controls the motor excitation if the detection process deemed it necessary to excite the motor.

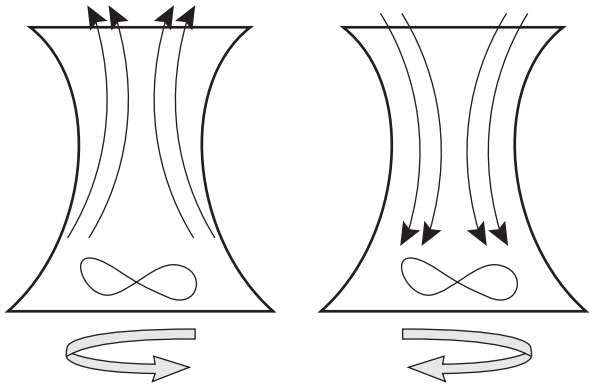
P363 [FS Reconnect Dly]
Delay time used between the issued start command and the start of the reconnect function. This is mainly used for power loss situations so the restart doesn't occur too quickly causing possible faults.

P364 [FS Msrmnt CurLvl]
There are two different measurement methods used when in Enhanced mode. If this parameter is set to zero the second method is cancelled and reconnect will be attempted after the first measurement. Any other level change in this parameter could help the second measurement routine. Usually a higher number helps more.

Cooling Tower Fans Application Example

In some applications, such as large fans, wind or drafts may rotate the fan in the reverse direction when the drive is stopped. If the drive were started in the normal manner, its output would begin at zero Hz, acting as a brake to bring the reverse rotating fan to a stop and then accelerating it in the correct direction. This operation can be very hard on the mechanics of the system including fans, belts and other coupling devices.

Draft/wind blows idle fans in reverse direction. Restarting at zero speed and accelerating damages fans and could break belts. Flying start alleviates the problem.



There could be occasions when the sweep as well as the CEMF detection fails at low speeds. This is due to the low levels of motor detection signals. It has been discovered that Sweep mode is more successful in these cases than Enhanced mode.

When in Sweep mode the frequency is always swept in the direction of the commanded frequency first.

Motor detection at low speeds can be difficult. Rather than get a false detection, the sweep will reverse at 3 Hz.

Hand-Off-Auto

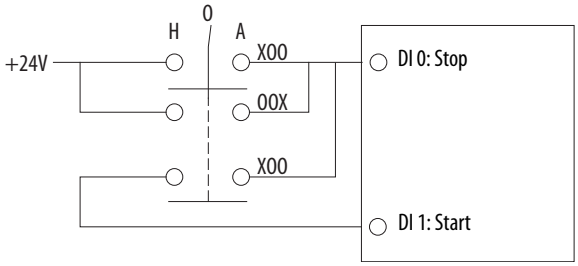
Many legacy drive installations included a circuit (such as a Hand-Off-Auto switch) that provided 3-wire start and stop signals simultaneously to the drive. The PowerFlex 750-series drives will not start unless there is a full input cycle between the stop and start signals. P176 [DI HOA Start] adds a delay to the start signal, allowing the required time interval between the start and stop signals. This enables the use of a single 3-wire control circuit to start and stop the drive.

Hand-Off-Auto Start

If [Digital Input Start] and [Digital Input Hand-Off-Auto Start] are both configured, the drive will alarm "DigIn Cfg B." You cannot use both Digital Input Start and Digital Input Hand-Off-Auto Start at the same time.

Hand-Off-Auto Example

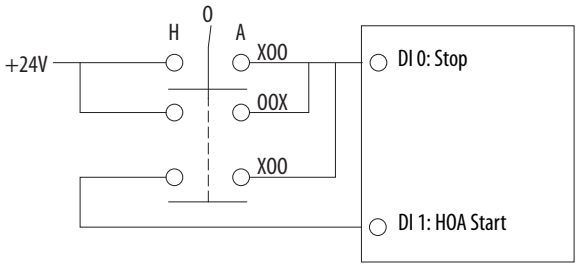
A Motor Control Cabinet has an Hand-Off-Auto switch wired as shown in the figure below.



When the switch is turned to Off, the switch is open between the source and Stop (DI:0) and between Stop and Start (DI:1). This causes the drive to be in an asserted stop. When the switch is turned to Auto, the control signal reaches the Stop input but not the Start. This allows the drive to be stopped and started by another location. When the switch is turned to Hand, both the Stop and Start ports are energized.

In order for the drive to start, the Stop signal must be received prior to the Start. With the wiring above, the signals are nearly simultaneous, too fast to be sure that the drive is ready to start. This causes the switch to either be unreliable or not work at all. This can be remedied by adding a time delay to the start signal. By changing Digital Input 1 from DI Start to DI Hand-Off-Auto Start, the drive

will automatically add this time delay and be sure that the system is ready to start before it receives the command.

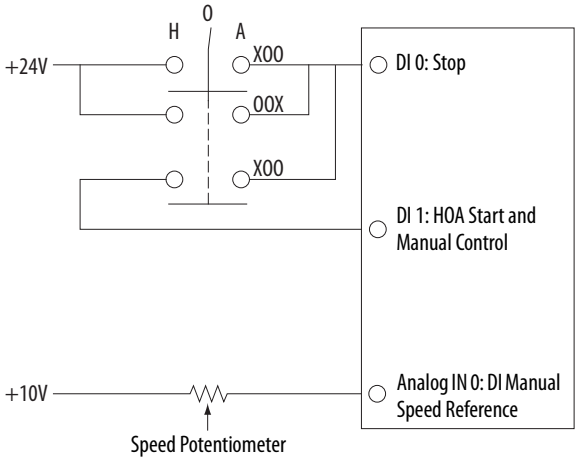


Using Hand-Off-Auto with Auto/Manual

In order to take control of the drive speed when switching from Auto to Hand on the H-O-A switch, the Auto/Manual feature can be used. See PowerFlex 750 - Auto Manual for more on Auto/Manual Control.

In the circuit below, a speed potentiometer was added to the analog input to provide a speed reference to the drive. When the H-O-A switch is moved from Auto to Hand, the digital input block will request manual control and issue a start command to the drive. If the digital input port receives manual control, the drive will accelerate to the reference speed from the analog input. All attempts to change the speed except from the analog input will be blocked. If the drive is stopped while in Hand, switch the H-O-A switch to Off and then back to Hand to restart the drive.

If another port has manual control of the drive, but does not have exclusive ownership of the logic commands (due to P326 [Manual Cmd Mask]), turning the switch to Hand will cause the drive to begin moving but for the analog input to have no control over the speed.



For this circuit, set the following parameters (P301 [Access Level] must be set to 1 "Advanced" to see P563 [DI ManRef Sel]).

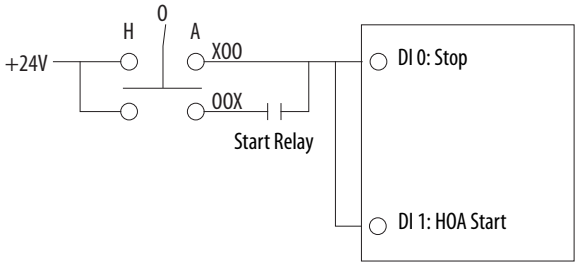
Number	Parameter Name	Value
158	DI Stop	Digital Input 0
172	DI Manual Control	Digital Input 1
176	DI HOA Start	Digital Input 1
324	Logic Mask	xxxxxxxxxxxxxx1 (Digital In)
326	Manual Cmd Mask	xxxxxxxxxxxxxx1 (Digital In)
327	Manual Ref Mask	xxxxxxxxxxxxxx1 (Digital In)
563	DI Manual Reference Select	Anlg In0 Value

The drive should now request Manual mode, start and track the reference speed coming from the Analog Input when the H-O-A switches to Hand. (The HIM will still read Auto. This display changes only when the HIM has control of Manual mode).

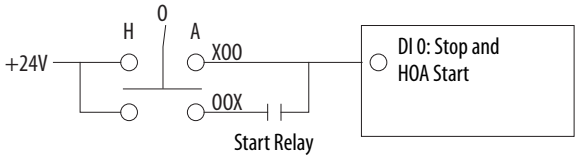
Using Hand-Off-Auto with a Start Relay

The Hand-Off-Auto switch can also be wired to ability to start the drive through a separate start relay.

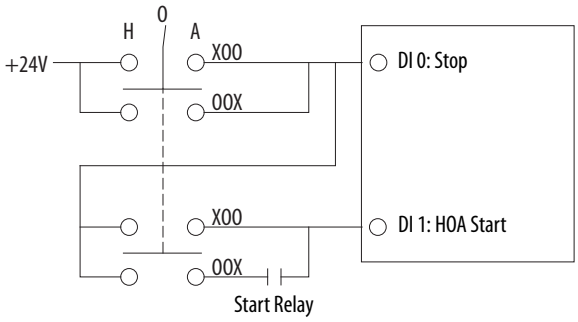
In the circuit below, the run relay will close the circuit to both the stop and start inputs when the H-O-A switch is in Auto. Using this option would allow the drive to start only if the H-O-A switch is in Hand or if it in Auto and the Run Relay is energized. No network or HIM control of the drive would be possible.



The above circuit can also be accomplished with a single digital input. Unlike P161 [DI Start], P176 [DI HOA Start] can share the same physical input with P158 [DI Stop]. The circuit can thus become the following.



To use the H-O-A switch, the run relay and allow for network or HIM control, the circuit can be wired as in the figure below.



Here, the stop input is high when the H-O-A switch is in the Hand or Auto position. This eliminates the asserted stop caused when the stop input is low, allowing for the drive to be started from several sources when the H-O-A switch is in the Auto position.

Masks

A mask is a parameter that contains one bit for each of the possible ports for the respective PowerFlex 750-Series drive. Each bit acts like a valve for issued commands. Closing the valve (setting a bit value to 0) stops the command from reaching the drive. Opening the valve (setting a bit value to 1) allows the command to pass through the mask into the drive.

Table 4 - Mask Parameters and Functions

Parameter Name	Parameter Number	Function
Dig In Filt Mask(1)	222	Digital Input Filter Mask. Filters the selected digital input.
Logic Mask	324	Enables/disables ports to control the logic command (such as start and direction). Does not mask Stop commands.
Auto Mask	325	Enables/disables ports to control the logic command (such as start and direction), while in Auto mode. Does not mask Stop commands.
Manual Cmd Mask	326	Enables/disables ports to control the logic command (such as start and direction), while in Manual mode. Does not mask Stop commands.
Manual Ref Mask	327	Enables/disables ports to control the speed reference while in Manual mode. When a port is commanding Manual mode, the reference is forced to the commanding port if the respective bit in this parameter is set. If an alternate speed reference source is desired, use P328 [Alt Man Ref Sel] to select the source.
Port Mask Act(2)	885	Active status for port communication. Bit 15 "Security" determines if network security is controlling the logic mask instead of this parameter.
Logic Mask Act(2)	886	Active status of the logic mask for ports. Bit 15 "Security" determines if network security is controlling the logic mask instead of this parameter.
Write Mask Act(2)	887	Active status of write access for ports. Bit 15 "Security" determines if network security is controlling the write mask instead of this parameter.
Write Mask Cfg	888	Enables/disables write access (parameters, links, and so forth.) for DPI ports. Changes to this parameter become effective only when power is cycled, the drive is reset or Bit 15 of P887 [Write Mask Actv], transitions from "1" to "0."
Dig In Filt Mask(3)	2	Digital Input Filter Mask. Filters the selected digital input.

(1) Used only by the PowerFlex 753 main control board.

(2) Read only parameter.

(3) Used only by I/O Module models 20-750-2263C-1R2T and 20-750-2262C-2R. (Modules with 24V DC inputs.)

The individual bits for each parameter are as follows.

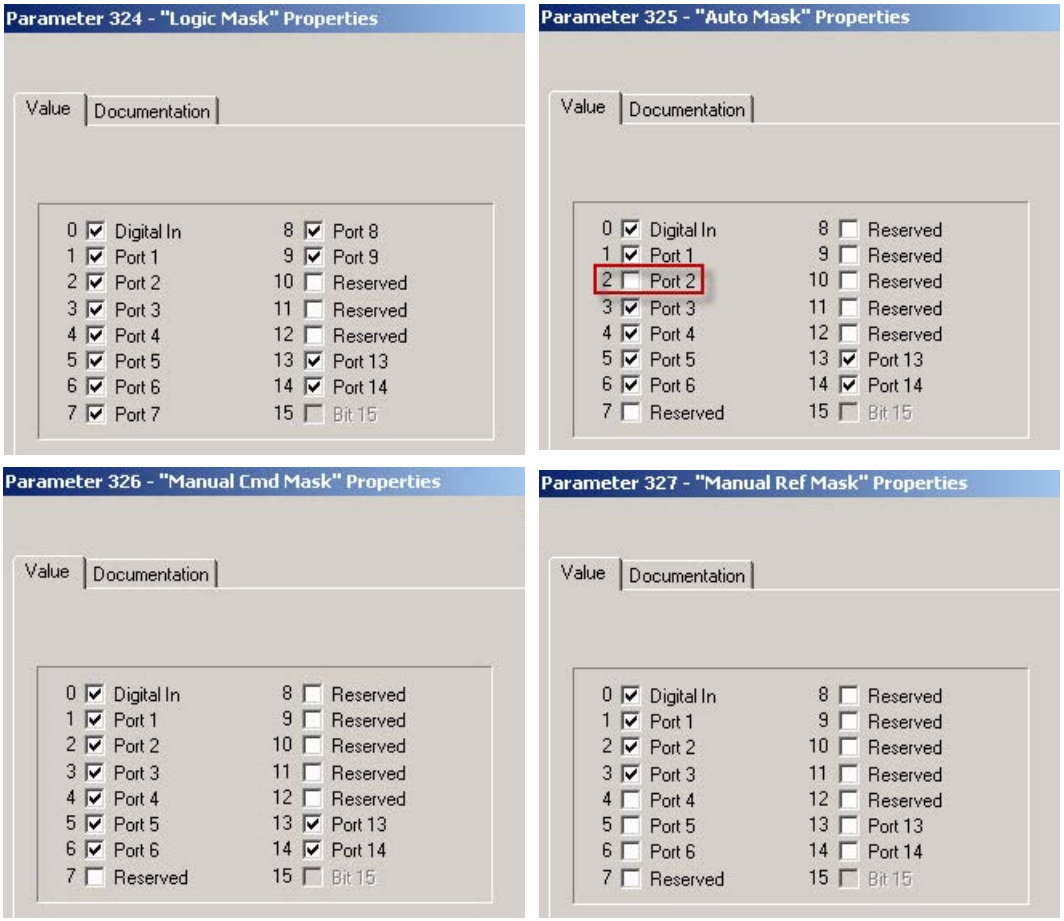
Table 5 - Mask Parameters with Bit Designations

	P222 [Dig In Filt Mask] (1)	P324 [Logic Mask]	P325 [Auto Mask]	P326 [Manual Cmd Mask]	P327 [Manual Ref Mask]	P885 [Port Mask Act]	P886 [Logic Mask Act]	P887 [Write Mask Act]	P888 [Write Mask Cfg]	P2 [Dig In Filt Mask](4)
Bit 0	Reserved	Digital In	Digital In	Digital In	Digital In	Digital In	Digital In	Reserved	Reserved	Input 0
Bit 1	Input 1	Port 1	Port 1	Port 1	Port 1	Port 1	Port 1	Port 1	Port 1	Input 1
Bit 2	Input 2	Port 2	Port 2	Port 2	Port 2	Port 2	Port 2	Port 2	Port 2	Input 2
Bit 3	Reserved	Port 3	Port 3	Port 3	Port 3	Port 3	Port 3	Port 3	Port 3	Input 3
Bit 4	Reserved	Port 4	Port 4	Port 4	Port 4	Port 4	Port 4	Port 4	Port 4	Input 4
Bit 5	Reserved	Port 5	Port 5	Port 5	Port 5	Port 5	Port 5	Port 5	Port 5	Input 5
Bit 6	Reserved	Port 6	Port 6	Port 6	Port 6	Port 6	Port 6	Port 6	Port 6	Reserved
Bit 7	Reserved	Port 7	Reserved	Reserved	Reserved	Port 7	Reserved	Port 7	Port 7	Reserved
Bit 8	Reserved	Port 8	Reserved	Reserved	Reserved	Port 8	Reserved	Port 8	Port 8	Reserved
Bit 9	Reserved	Port 9	Reserved	Reserved	Reserved	Port 9	Reserved	Port 9	Port 9	Reserved
Bit 10	Reserved	Port 10(2)	Reserved	Reserved	Reserved	Port 10(2)	Reserved	Port 10(2)	Port 10(2)	Reserved
Bit 11	Reserved	Port 11(2)	Reserved	Reserved	Reserved	Port 11(2)	Reserved	Port 11(2)	Port 11(2)	Reserved
Bit 12	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Bit 13	Reserved	Port 13(3)	Port 13(3)	Port 13(3)	Port 13(3)	Port 13(3)	Port 13(3)	Port 13(3)	Port 13(3)	Reserved
Bit 14	Reserved	Port 14	Port 14	Port 14	Port 14	Port 14	Port 14	Port 14	Port 14	Reserved
Bit 15	Reserved	Reserved	Reserved	Reserved	Reserved	Security	Security	Security	Security	Reserved

(1) Used only by the PowerFlex 753 main control board.
(2) PowerFlex 755 Frame 8 drives and larger only.
(3) PowerFlex 755 drives only.
(4) Used only by I/O Module models 20-750-2263C-1R2T and 20-750-2262C-2R. (Modules with 24V DC inputs.)

Example

You are controlling a PowerFlex 755 drive via the embedded ethernet (Port 13) remotely by a PLC. In normal operation he would like to prevent any type of controls being issued from the remote HIM (Port 2). However, in some cases, he would still like the ability to manually control the drive via the HIM. To assure these two modes of control, masks can be set as follows.



This masks out (disables) the remote HIM (Port 2) to control the logic command word (such as start, jog and direction) when the drive is in Auto mode and allows (enables) the HIM to control the logic command word when the drive is in Manual mode.

Power Loss

The drive contains a sophisticated algorithm to manage initial application of power as well as recovery from a partial power loss event. The drive also has programmable features that can minimize the problems associated with a loss of power in certain applications.

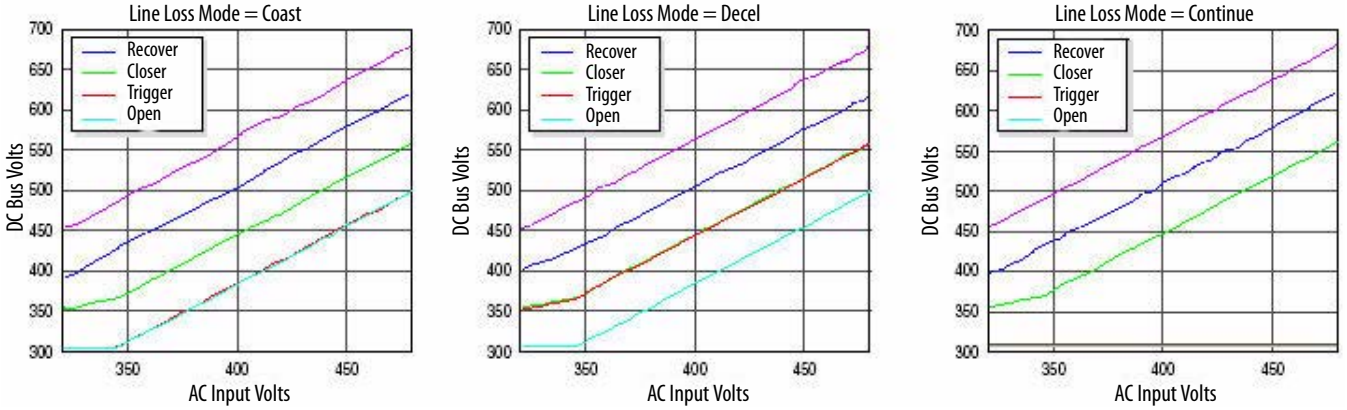
Terms and Definitions

Term	Definition
Vbus	The instantaneous DC bus voltage.
Vmem	The average DC bus voltage. A measure of the average bus voltage determined by heavily filtering bus voltage. Just after the pre-charge relay is closed during the initial power-up bus pre-charge, bus memory is set equal to bus voltage. Thereafter it is updated by ramping at a very slow rate toward Vbus. The filtered value ramps at 2.4V DC per minute (for a 480VAC drive). An increase in Vmem is blocked during deceleration to prevent a false high value due to the bus being pumped up by regeneration. Any change to Vmem is blocked during inertia ride through.
Vslew	The rate of change of Vmem in volts per minute.
Vrecover	The threshold for recovery from power loss.
Vtrigger	The threshold to detect power loss. The level is adjustable. The default is the value in the PowerFlex 750-Series Bus Level table. If "Pwr Loss Lvl" is selected as an input function AND energized, Vtrigger is set to Vmem minus [Pwr Loss Level]. Vopen is normally 60V DC below Vtrigger (in a 480VAC drive). Both Vopen and Vtrigger are limited to a minimum of Vmin. This is a factor only if [Pwr Loss Level] is set to a large value. **Important**: When using a value of P451/P454 [Pwr Loss A/B Level] larger than default, you must provide a minimum line impedance to limit inrush current when the power line recovers. The input impedance should be equal or greater than the equivalent of a 5% transformer with a VA rating 5 times the drive's input VA rating.
Vinertia	The software regulation reference for Vbus during inertia ride through.
Vclose	The threshold to close the pre-charge contactor.
Vopen	The threshold to open the pre-charge contactor.
Vmin	The minimum value of Vopen.
Voff	The bus voltage below which the switching power supply falls out of regulation.

Table 6 - PowerFlex 750-Series Bus Levels

Class	200/240 VAC	400/480 VAC	600/690 VAC
Vslew	1.2V DC	2.4V DC	3.0V DC
Vrecover	Vmem – 30V	Vmem – 60V	Vmem – 75V
Vclose	Vmem – 60V	Vmem – 120V	Vmem – 150V
Vtrigger1,2	Vmem – 60V	Vmem – 120V	Vmem – 150V
Vtrigger1,3	Vmem – P451/P454 [Power Loss A/B Level]	Vmem – P451/P454 [Power Loss A/B Level]	Vmem – P451/P454 [Power Loss A/B Level]
Vopen	Vmem – P451/P454 [Power Loss A/B Level]	Vmem – P451/P454 [Power Loss A/B Level]	Vmem – P451/P454 [Power Loss A/B Level]
Vopen4	153V DC	305V DC	382V DC
Vmin	153V DC	305V DC	382V DC
Voff	–	200V DC	–

In the following diagram, the x-axis across the bottom indicates what the input voltage is into the drive and the y-axis indicates the corresponding DC Bus Voltage. Then the levels of each event are indicated in the graph. For example if I measure at the input of my drive, 450 volts - phase to phase, I find that voltage across the bottom. Now the various voltage levels can be derived according to that voltage level.



Restart after Power Recovery

If a power loss causes the drive to coast and power recovers the drive will return to powering the motor if it is in a Run Permit state. The drive is in a Run Permit state if the following is true:

- **3 Wire mode** - it is not faulted and if all Enable and Not Stop inputs are energized.
- **2 Wire mode** - it is not faulted and if all Enable, Not Stop, and Run inputs are energized.

Power Loss Modes

The drive is designed to operate at a nominal input voltage. When voltage falls below this nominal value by a significant amount, action can be taken to preserve the bus energy and keep the drive logic alive as long as possible. The drive has three methods of dealing with low bus voltages:

- "Coast" - Disable the drive and allow the motor to coast. (default)
- "Decel" - Decelerate the motor at a rate that will regulate the DC bus until the load's kinetic energy can no longer power the drive.
- "Continue" - Allow the drive to power the motor down to 50% of the nominal DC bus voltage. When power loss occurs, P959 [Alarm Status A] Bit 0 turns on if the P449 [Power Loss Actn] is set to 1 "Alarm."

If the P449 [Power Loss Actn] is set to 3 "FltCoastStop," the drive will fault with a F3 "Power Loss" fault when the power loss event exceeds P452/455 [Pwr Loss A/B Time].

The drive faults with a F4 “UnderVoltage” fault if the bus voltage falls below Vmin and the P460 [UnderVltgAction] is set to 3 “FltCoastStop.”

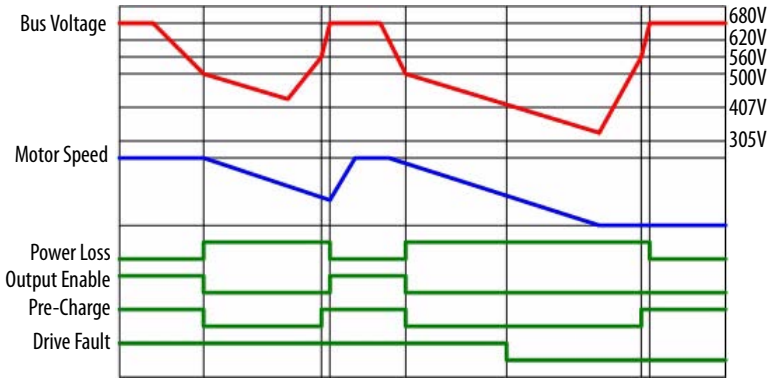
The pre-charge relay opens if the bus voltage drops below Vopen and closes if the bus voltage rises above Vclose.

If the bus voltage rises above Vrecover for 20 ms, the drive determines the power loss is over. The power loss alarm is cleared.

If the drive is in a Run Permit state, the reconnect algorithm is run to match the speed of the motor. The drive then accelerates at the programmed rate to the set speed.

Coast

This is the default mode of operation. The drive determines a power loss has occurred if the bus voltage drops below Vtrigger. If the drive is running, the inverter output is disabled and the motor coasts.



Decel

This mode of operation is useful if the mechanical load is high inertia and low friction. By recapturing the mechanical energy, converting it to electrical energy and returning it to the drive, the bus voltage is maintained. As long as there is mechanical energy, the ride through time is extended and the motor remains fully fluxed.

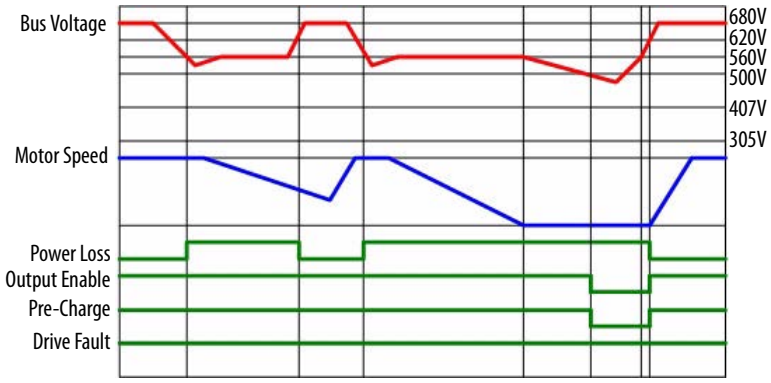
If AC input power is restored, the drive can ramp the motor to the correct speed without the need for reconnecting. The drive determines a power loss has occurred if the bus voltage drops below Vtrigger.

If the drive is running, the inertia ride through function is activated.

The load is decelerated at the correct rate so that the energy absorbed from the mechanical load regulates the DC bus to the value Vinertia.

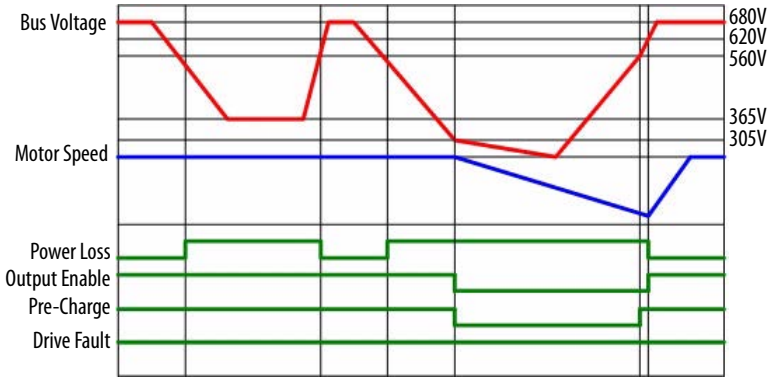
The inverter output is disabled and the motor coasts if the output frequency drops to zero or if the bus voltage drops below Vopen or if any of the Run Permit inputs are de-energized.

If the drive is still in inertia ride through operation when power returns, the drive immediately accelerates at the programmed rate to the set speed. If the drive is coasting and it is in a Run Permit state, the reconnect algorithm is run to match the speed of the motor. The drive then accelerates at the programmed rate to the set speed.



Continue

This mode provides the maximum power ride through. The input voltage can drop to 50% and the drive is still able to supply drive rated current (not drive rated power) to the motor.

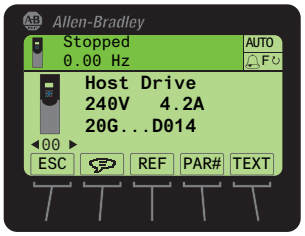


ATTENTION: To guard against drive damage, a minimum line impedance must be provided to limit inrush current when the power line recovers. The input impedance should be equal or greater than the equivalent of a 5% transformer with a VA rating 6 times the drive's input VA rating.

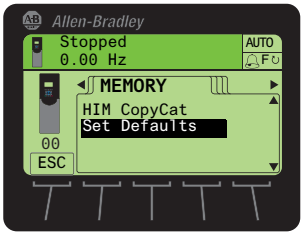
ATTENTION: Drive damage can occur if proper input impedance is not provided as explained below. If the value for [Power Loss Level] is greater than 18% of [DC Bus Memory], you must provide a minimum line impedance to limit inrush current when the power line recovers. The input impedance should be equal to or greater than the equivalent of a 5% transformer with a VA rating 5 times the drives input VA rating.

Reset Parameters to Factory Defaults

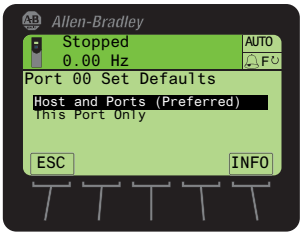
1. Access the Status Screen on the 20-HIM-A6 or 20-HIM-CS6 Human Interface Module.



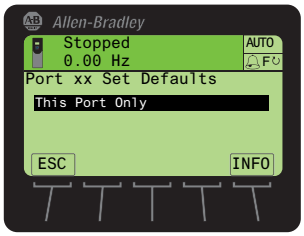
2. Use the left-right arrow keys to scroll to the port of the device whose parameters you want to set to factory defaults (for example, Port 00 for the Host Drive or the respective port number for the drive's connected peripherals).
3. Press the Folder key next to the green Start key to display its last-viewed folder.
4. Use the left-right arrow keys to scroll to the Memory folder.
5. Use the up-down arrow keys to select Set Defaults.



6. Press the Enter (5) key to display the Set Defaults screen.



For Host Drive



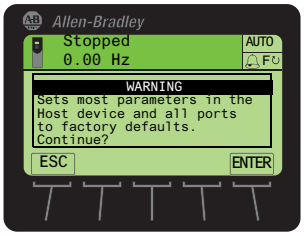
For Connected Peripheral

7. Use the up-down arrow keys select the appropriate action.
   - Host and Ports (Preferred): Selects the Host device and all ports for a factory default action.

- This Port Only: Selects only this port for a factory default action. (For a description of a selected menu item, press the INFO soft key)

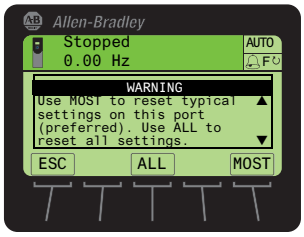
8. Press the Enter (5) key to display the warning pop-up box to reset defaults.

Host and Ports (preferred) Pop-up Box



Press the ENTER *soft key* to affirm and set most parameters for the Host Drive and port devices to factory defaults. In this case, refer to the Host Drive and port device user manuals for the settings that will NOT be restored—or press the ESC *soft key* to cancel.

This Port Only Pop-up Box



Press the MOST *soft key* to set MOST settings for the selected port device to factory defaults. In this case, refer to the Host Drive User Manual for the settings that will NOT be restored. Press the ALL *soft key* to set ALL settings for the selected port device to factory defaults—or press the ESC *soft key* to cancel.

A pop-up Fault warning display will follow the parameter changes. This can be reset by pressing the clear soft key. And the following confirm pop-up box can be cleared by pressing the enter soft key. Pressing the escape key twice will return the display to the Status screen.

Refer to the PowerFlex 20-HIM-A6/-C6S HIM (Human Interface Module) User Manual, publication 20HIM-UM001, for further information on using the HIM and the resetting of parameters.

Sleep/Wake Mode

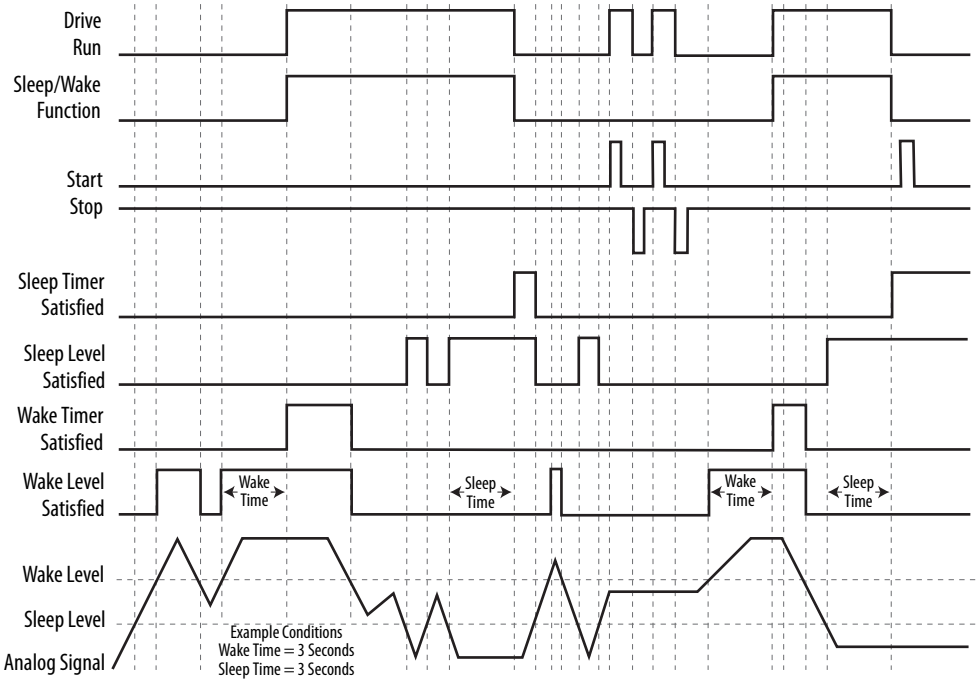
The purpose of the sleep/wake function is to Start (wake) the drive when an SleepWake RefSel signal is greater than or equal to the value in P354 [Wake Level], and Stop (sleep) the drive when an analog signal is less than or equal to the value in P352 [Sleep Level]. Setting P350 [Sleep Wake Mode] to 1 "Direct" enables the sleep/wake function to work as described.

An Invert mode also exists, which changes the logic so that an analog value less than or equal to P354 [Wake Level] starts the drive and an SleepWake RefSel signal greater than or equal to P352 [Sleep Level] stops the drive.

Related Sleep/Wake parameters noted below.

Parameter No.	Parameter Name	Description
350	Sleep Wake Mode	Enables/disables the Sleep/Wake function.
351	SleepWake RefSel	Selects the source of the input controlling the sleep/wake function
352	Sleep Level	Defines the SleepWake RefSel signal level that will stop the drive
353	Sleep Time	Defines the amount of time at or below 352 [Sleep Level] before a Stop is issued
354	Wake Level	Defines the SleepWake RefSel signal level that will start the drive
355	Wake Time	Defines the amount of time at or above 354 [Wake Level] before a Start is issued

Sleep/Wake Operation



Requirements

In addition to enabling the sleep function with P350 [Sleep Wake Mode], the following conditions must be met:

- A proper value must be programmed for P352 [Sleep Level] and P354 [Wake Level].
- A sleep/wake reference must be selected in P351 [SleepWake RefSel].
- At least one of the following must be programmed (and input closed) in P155 [DI Enable], P158 [DI Stop], P163 [DI Run], P164 [DI Run Forward], or P165 [DI Run Reverse].

Conditions to Start/Restart

ATTENTION: Enabling the sleep/wake function can cause unexpected machine operation during the Wake mode. Equipment damage and/or personal injury can result if this parameter is used in an inappropriate application. Do not use this function without considering the Table 7 below and applicable local, national and international codes, standards, regulations or industry guidelines.

Table 7 - Conditions Required to Start Drive (1) (2) (3)

Input	After Powerup	After a Drive Fault		After a Stop Command
		Reset by HIM or Software "Stop"	Reset by HIM, Network/Software, or Digital Input "Clear Faults"	HIM, Network/Software or Digital Input "Stop"
Stop(4)	Stop Closed Wake Signal New Start or Run Command(5)	Stop Closed Wake Signal New Start or Run Command(5)	Stop Closed Wake Signal	Stop Closed Direct mode: SleepWake RefSel Signal > Sleep Level(7) Invert mode: SleepWake RefSel Signal < Sleep Level(8) New Start or Run Command(5)
Enable	Enable Closed Wake Signal	Enable Closed Wake Signal New Start or Run Command(5)	Enable Closed Wake Signal	Enable Closed Direct mode: SleepWake RefSel Signal > Sleep Level(7) Invert mode: SleepWake RefSel Signal < Sleep Level(8) New Start or Run Command(5)
Run Run Forward Run Reverse	Run Closed Wake Signal	New Run Command(6) Wake Signal	Run Closed Wake Signal	New Run Command Direct mode: SleepWake RefSel Signal > Sleep Level(7) Invert mode: SleepWake RefSel Signal < Sleep Level(8)

(1) When power is cycled, if all conditions are present after power is restored, restart will occur.
(2) If all conditions are present when [Sleep-Wake Mode] is "enabled," the drive will start.
(3) The active speed reference. The Sleep/Wake function and the speed reference may be assigned to the same input.
(4) Cannot use P159 [DI Cur Lmt Stop] or P160 [DI Coast Stop] as the only Stop Input. This will cause the drive to go into a Sleep Cfg Alarm - Event No. 161.
(5) Command must be issued from HIM, TB or network.
(6) Run Command must be cycled.
(7) SleepWake Ref Sel signal does not need to be greater than the wake level.
(8) SleepWake Ref Sel signal does not need to be less than the wake level.

For Invert function, refer to the [Anlg In*n* LssActn] parameter.

Normal operation will require that P354 [Wake Level] be set greater than P352 [Sleep Level]. However, there are no limits that prevent the parameter settings from crossing, but the drive will not start until such settings are corrected. These levels are programmable while the drive is running. If P352 [Sleep Level] is made greater than P354 [Wake Level] while the drive is running, the drive will continue to run as long as the P351 [SleepWake RefSel] signal remains at a level that doesn't trigger the sleep condition. P353 [Sleep Time] is also factored into this as well. Once the drive goes to sleep in this situation, it will not be allowed to restart until the level settings are corrected (increase P354 [Wake Level], or decrease P352 [Sleep Level]). If however, the levels are corrected prior to the drive going to sleep, normal Sleep/Wake operation will continue.

Timers

P353 [Sleep Time]
P355 [Wake Time]

Timers will determine the length of time required for Sleep/Wake levels to produce true functions. These timers will start counting when the Sleep/Wake levels are satisfied and will count in the opposite direction whenever the respective level is dissatisfied. If the timer counts all the way to the user specified time, it creates an edge to toggle the Sleep/Wake function to the respective condition (sleep or wake). On powerup, timers are initialized to the state that does not permit a start condition. When the analog signal satisfies the level requirement, the timers start counting.

Interactive Functions

Separate start commands are also honored (including a digital input start), but only when the sleep timer is not satisfied. Once the sleep timer times out, the sleep function acts as a continuous stop. There are two exceptions to this, which will ignore the Sleep/Wake function.

1. When a device is commanding local control, that is HIM in Manual mode or a digital input programmed to P172 [DI Manual Ctrl].
2. When a jog command is being issued.

When a device is commanding local control, the port that is commanding it has exclusive start control (in addition to ref select), essentially overriding the Sleep/Wake function, and allowing the drive to run in the presence of a sleep situation. This holds true even for the case if digital input is programmed to P172 [DI Manual Ctrl], a digital input start or run will be able to override a sleep situation.

Sleep/Wake Sources

The P351 [SleepWake RefSel] signal source for the sleep/wake function can be any analog input, whether it is being used for another function or not, a DeviceLogix software source (P90 [DLX Real OutSP1] thru P97 [DLX Real OutSP8]), or a valid numeric edit configuration. Configuring the sleep/wake source is done through P351 [SleepWake RefSel].

Also, [Anlg In*n* Hi] and [Anlg In*n* Lo] parameters have no effect on the function, however, the factory calibrated result, [Anlg In*n* Value] parameter, is used. In addition, the absolute value of the calibrated result is used, thus making the function useful for bipolar direction applications.

The analog in loss function, configured by the [Anlg In*n* LssActn] parameter, is unaffected and therefore operational with the sleep/wake function, but not tied to the sleep or wake levels and is triggered off the [Anlg In*n* Raw Value] parameter.

Refer to the PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001, for more details.

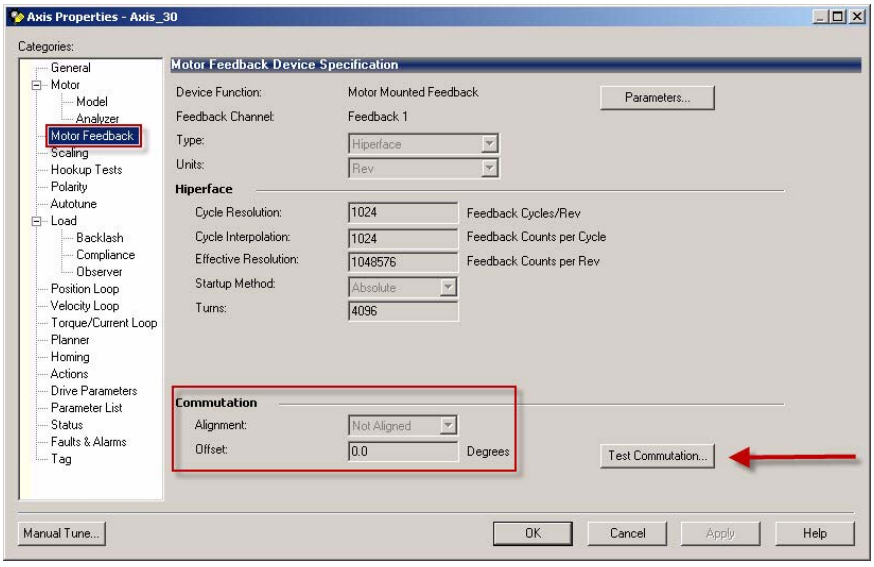
Start Permissives

Start permissives are conditions required to permit the drive to start in any mode, such as run, jog, or auto-tune. When all permissive conditions are met, the drive is considered ready to start. The ready condition is confirmed through the ready status in P935 [Drive Status 1].

Permissive Conditions

1. No faults can be active.
2. No Type 2 alarms can be active.
3. The DI Enable input, if configured, must be closed.
4. The DC bus precharge logic must indicate it is a start permissive.
5. All Stop inputs must be negated nor any drive functions are issuing a stop.
6. No configuration changes (parameters being modified) can be in-progress.
7. The drive's safety option module logic must be satisfied.

If a CIP Motion connection is active and if alignment is set to "Not Aligned" then the "CommutNotCfg" bit will be high (on). To clear this start inhibit, from the Axis Properties within RSLogix 5000 software, run a Commutation Test, enter the proper value into the Offset and then set the Alignment to "Controller Offset."



If all permissive conditions are met, a valid start, run or jog command will start the drive. The status of all current inhibit conditions are reflected in P933 [Start Inhibits] and the last inhibit conditions are reflected in P934 [Last StrtInhibit] details are shown below.

File	Group	No.	Display Name Full Name Description	Values	Read-Write	Data Type
DIAGNOSTICS	Status	933	**Start Inhibits** Start Inhibits Indicates which condition is preventing the drive from starting or running.		RO	32-bit Integer

Options	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	CommutNotCfg	Profiler (1)	Sleep	Safety	Startup	Database	Stop	Precharge	Enable	Alarm	Faulted
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

(1) PowerFlex 755 drives only.

0 = False, 1 = True

Bit 0 "Faulted" – Drive is in a faulted state. See P951 [Last Fault Code].
Bit 1 "Alarm" – A Type 2 alarm exists. See P961 [Type 2 Alarms].
Bit 2 "Enable" – An Enable input is open.
Bit 3 "Precharge" – Drive is in precharge. See P321 [Prchrg Control], P11 [DC Bus Volts].
Bit 4 "Stop" – Drive is receiving a stop signal. See P919 [Stop Owner].
Bit 5 "Database" – Database is performing a download operation.
Bit 6 "Startup" – Startup is active and preventing a start. Go to Start-Up Routine and abort.
Bit 7 "Safety" – Safety option module is preventing a start.
Bit 8 "Sleep" – Sleep function is issuing a stop. See P 350 [Sleep Wake Mode], P351 [SleepWake RefSel].
Bit 9 "Profiler" – Profiler function is issuing a stop. See P1210 [Profile Status].
Bit 10 "CommutNotCfg" – The associated PM motor commutation function has not been configured for use.

File	Group	No.	Display Name Full Name Description	Values	Read-Write	Data Type
DIAGNOSTICS	Status	934	**Last StrtInhibit** Last Start Inhibit Displays the Inhibit that prevented the last Start signal from starting the drive. Bits will be cleared after the next successful start sequence. See parameter 933 [Start Inhibits] for bit descriptions.		RO	32-bit Integer

Options	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	CommutNotCfg	Profilier	Sleep	Safety	Startup	Database	Stop	Precharge	Enable	Alarm	Faulted
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

0 = False, 1 = True

Stop Modes

Stop Mode A/B can be configured as a method of stopping the drive when a stop command is given. A normal stop command and the run input changing from true to false will result in a normal stop command. However, when using TorqueProve, P1100 [Trq Prove Cfg] with Bit 0 enabled, [Stop Mode A/B] must be set to 1 "Ramp."

A [Stop Dwell Time], P392 can also be used with a stop command. This can be used to set an adjustable time between detecting zero speed and turning off the drive output.

The PowerFlex 750 series offers several methods for stopping a load. The stop method or mode is defined by parameters 370/371 [Stop Mode A/B] These modes include the following:

- Coast
- Ramp
- Ramp to Hold
- DC Brake
- DC Brake Auto Off
- Current Limit
- Fast Brake

Additionally, P388 [Flux Braking] can be selected separately (not part of the Stop mode selection) to provide additional braking during a Stop command or when reducing the speed command. For Stop commands, this will provide additional braking power during "Ramp" or "Ramp to Hold" selections only. If "Fast Brake" or "DC Brake" is used, "Flux Braking" will be active only during speed changes (if enabled).

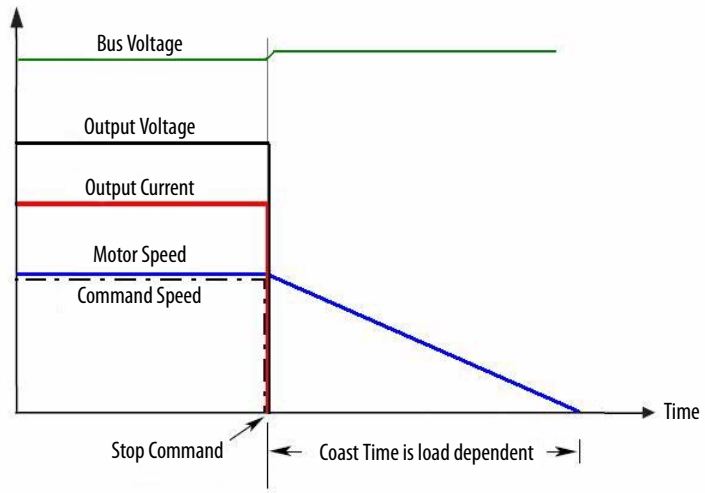
A "Ramp" selection will always provide the fastest stopping time if a method to dissipate the required energy from the DC bus is provided (that is Dynamic Braking resistor, regenerative brake, and so forth.). The PowerFlex Dynamic Braking Selection Guide presented in Appendix A of the Reference Manual, explains Dynamic Braking in detail.

The alternative braking methods to external hardware brake requirements, can be enabled if the stopping time is not as restrictive. Each of these methods will dissipate energy in the motor (use care to avoid motor overheating).

Braking Methods

Method	Use when application Requires	Braking Power
Coast	Power is removed from the motor and it coasts to zero speed	None
Ramp	The fastest stopping time or fastest ramp time for speed changes (external brake resistor or regenerative capability required for ramp times faster than the methods below). High duty cycles, frequent stops or speed changes. (The other methods may result in excessive motor heating).	The most
Ramp to Hold	Same as ramp above only when zero speed is reach the drive outputs a DC brake current to be sure the motor shaft doesn't move after it has stopped. This continues until the drive is started again.	Same as "Ramp"
DC Brake	DC braking is immediately applied (does not follow programmed decel ramp). May have to adjust P397 [DC Brake Kp].	Less than Ramp or Fast Brake
DCBrkAutoOff	Applies DC braking until zero speed is reached or DC brake time is reached, whichever is shorter.	Less than Ramp or Fast Brake
Current Lmt	Max torque / current applied until zero speed	Big Stuff
Fast Brake	High slip braking for maximum braking performance above base speed.	More than DC Brake / DC Brake Auto Off

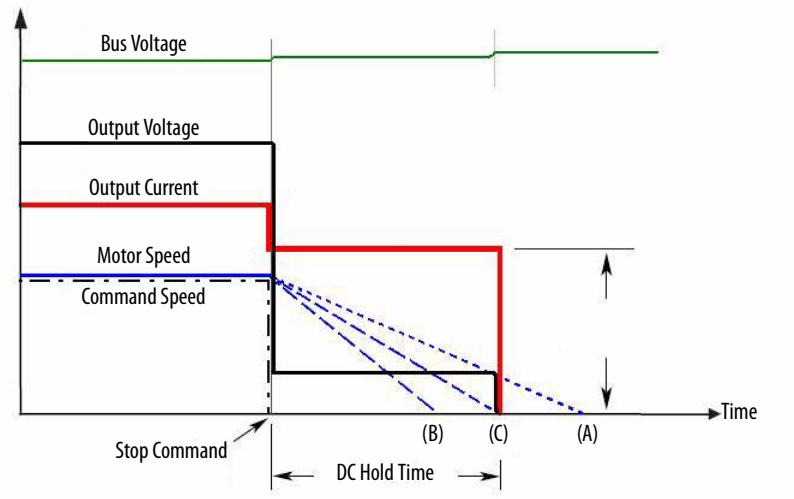
Coast



Coast is selected by setting [Stop Mode A/B] to 0 "Coast." When in Coast to Stop, the drive acknowledges the Stop command by shutting off the output and releasing control of the motor. The load/motor will coast or free spin until the kinetic energy is dissipated:

- On Stop, the drive output goes immediately to zero (off).
- No further power is supplied to the motor. The drive has released control.
- The motor will coast for a time that is dependent on the mechanics of the system (Inertia, friction, and so forth).

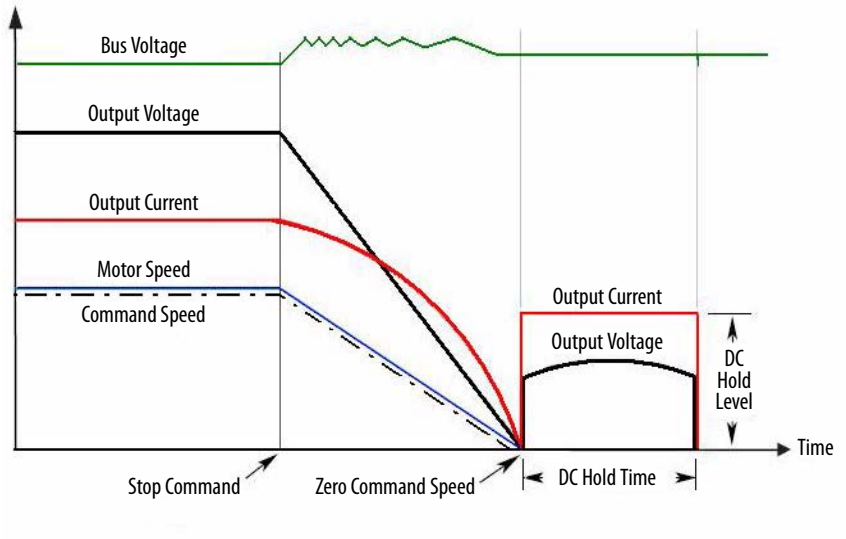
DC Brake



This method uses DC injection of the motor to Stop and/or hold the load. DC Brake is selected by setting [Stop Mode A/B] to 3 "DC Brake." You can also choose the amount of time the braking will be applied and the magnitude of the current used for braking with [DC Brake Time] and [DC Brake Level]. This mode of braking will generate up to 40% of rated motor torque for braking and is typically used for low inertia loads with infrequent Stop cycles:

- On Stop, 3 phase drive output goes to zero (off).
- Drive outputs DC voltage on the last used phase to provide the current level programmed in P394 [DC Brake Level]. This voltage causes a stopping brake torque. If the voltage is applied for a time that is longer than the actual possible stopping time, the remaining time will be used to attempt to hold the motor at zero speed (decel profile "B" on the diagram above).
- DC voltage to the motor continues for the amount of time programmed in P395 [DC BrakeTime]. Braking ceases after this time expires.
- After the DC Braking ceases, no further power is supplied to the motor. The motor/load may or may not be stopped. The drive has released control of the motor/load (decel profile "A" on the diagram above).
- The motor, if rotating, will coast from its present speed for a time that is dependent on the remaining kinetic energy and the mechanics of the system (inertia, friction, and so forth).
- Excess motor current and/or applied duration, could cause motor damage. Motor voltage can exist long after the Stop command is issued. The right combination of Brake Level and Brake Time must be determined to provide the safest, most efficient stop (decel profile "C" on the diagram above).

Ramp



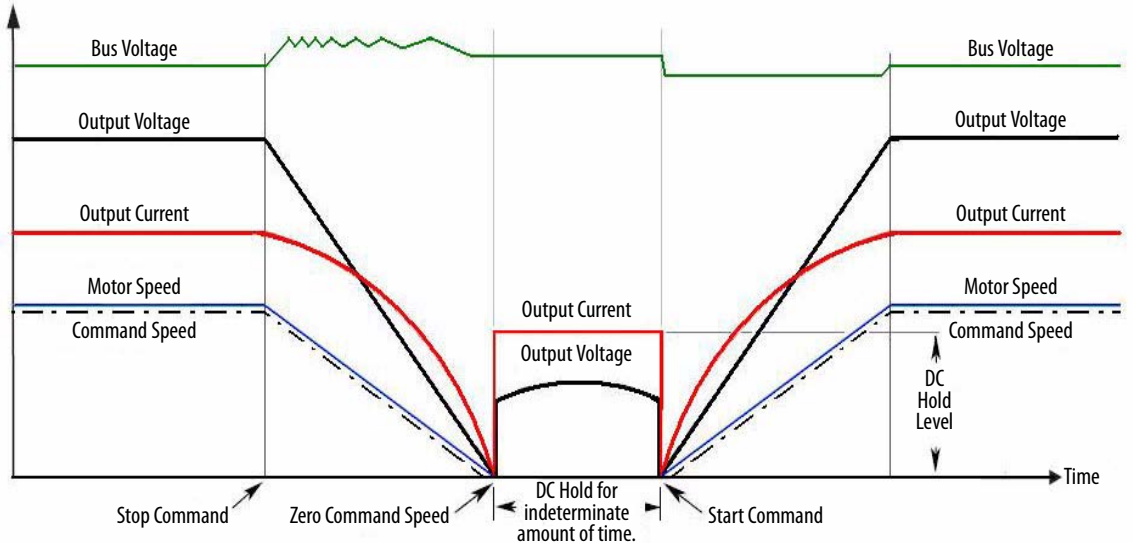
This method uses drive output reduction to stop the load.

Ramp To Stop is selected by setting parameters 370/371[Stop Mode A/B] to 1 "Ramp." The drive will ramp the frequency to zero based on the deceleration time programmed into parameters 537/538 [Decel Time 1/2]. The normal mode of machine operation can utilize [Decel Time 1]. If the machine Stop requires a faster deceleration than desired for normal deceleration, [Decel Time 2] can be activated with a faster rate selected. When in Ramp mode, the drive acknowledges the Stop command by decreasing or ramping the output voltage and frequency to zero in a programmed period (Decel Time), maintaining control of the motor until the drive output reaches zero. The drive output is then shut off. The load/motor should follow the decel ramp. Other factors such as bus regulation and current limit can alter the actual decel rate.

Ramp mode can also include a timed hold brake. Once the drive has reached zero output hertz on a Ramp-to-Stop and both parameters 395 [DC Brake Time] and P394 [DC Brake Level] are not zero, the drive applies DC to the motor producing current at the DC Brake Level for the DC Brake Time:

- On Stop, drive output will decrease according to the programmed pattern from its present value to zero. The pattern may be linear or squared. The output will decrease to zero at the rate determined by the programmed P520 [Max Fwd Speed] or P521 [Max Rev Speed] and the programmed active (Decel Time *n*).
- The reduction in output can be limited by other drive factors such as bus or current regulation.
- When the output reaches zero the output is shut off.
- The motor, if rotating, will coast from its present speed for a time that is dependent on the mechanics of the system (inertia, friction, and so forth).

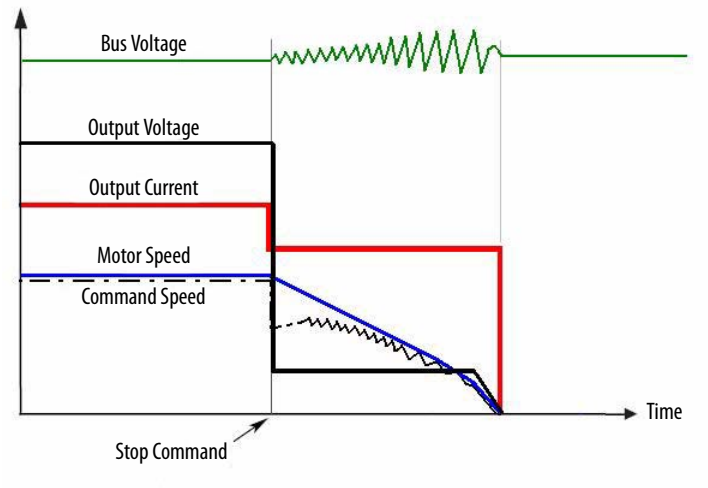
Ramp to Hold



This method combines two of the methods above. It uses drive output reduction to stop the Load and DC injection to hold the load at zero speed once it has stopped:

- On Stop, drive output will decrease according to the programmed pattern from its present value to zero. The pattern may be linear or squared. The output will decrease to zero at the rate determined by the programmed (Maximum Freq) and the programmed active (Decel Time x)
- The reduction in output can be limited by other drive factors such as bus or current regulation.
- When the output reaches zero 3 phase drive output goes to zero (off) and the drive outputs DC voltage on the last used phase to provide the current level programmed in P394 [DC Brake Level]. This voltage causes a holding brake torque.
- DC voltage to the motor continues until a Start command is reissued or the drive is disabled.
- If a Start command is reissued, DC Braking ceases and the drive returns to normal AC operation. If an Enable command is removed, the drive enters a Not Ready state until the enable is restored.

Fast Brake

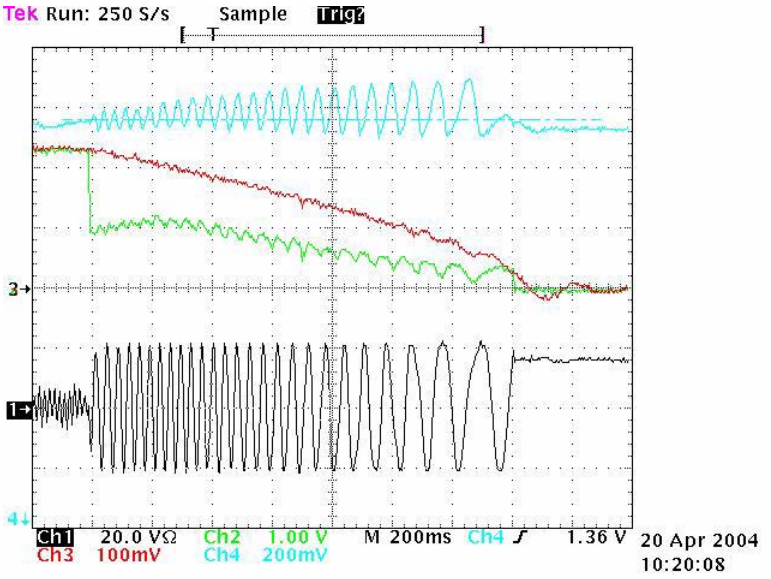


This method takes advantage of the characteristic of the induction motor whereby frequencies greater than zero (DC braking) can be applied to a spinning motor that will provide more braking torque without causing the drive to regenerate:

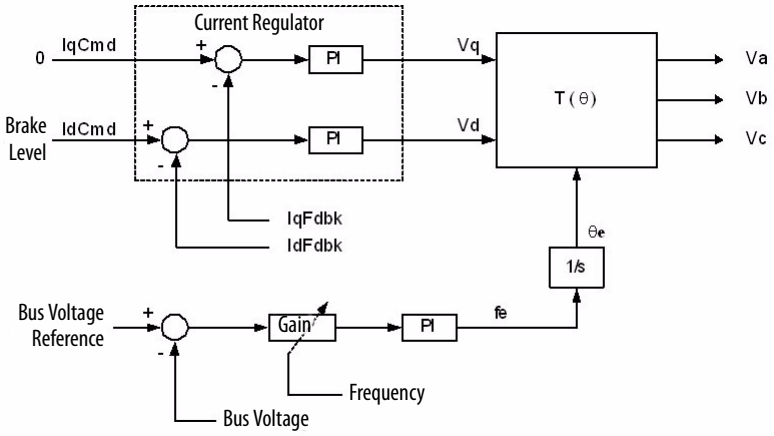
- On Stop, the drive output will decrease based on the motor speed, keeping the motor out of the regen region. This is accomplished by lowering the output frequency below the motor speed where regeneration will not occur. This causes excess energy to be lost in the motor.
- The method uses a PI based bus regulator to regulate the bus voltage to a reference (that is 750V) by automatically decreasing output frequency at the proper rate.
- When the frequency is decreased to a point where the motor no longer causes the bus voltage to increase, the frequency is forced to zero. DC brake will be used to complete the stop if the DC Braking Time is non-zero, then the output is shut off.
- Use of the current regulator verifies that over current trips don't occur and allow for an easily adjustable and controllable level of braking torque.
- Use of the bus voltage regulator results in a smooth, continuous control of the frequency and forces the maximum allowable braking torque to be utilized at all times.

IMPORTANT For this feature to function properly the active [Bus Reg Mode A/B] must be set to 1 "Adjust Freq" and **not** be 0 "Disabled."

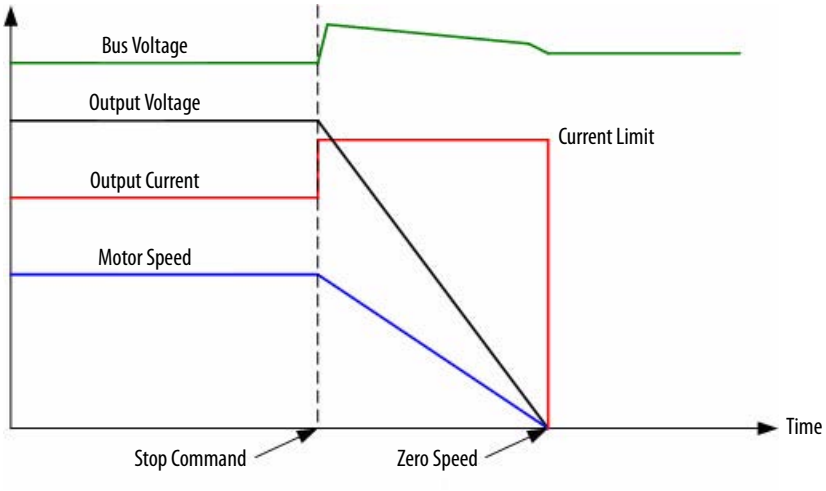
Example



Block Diagram



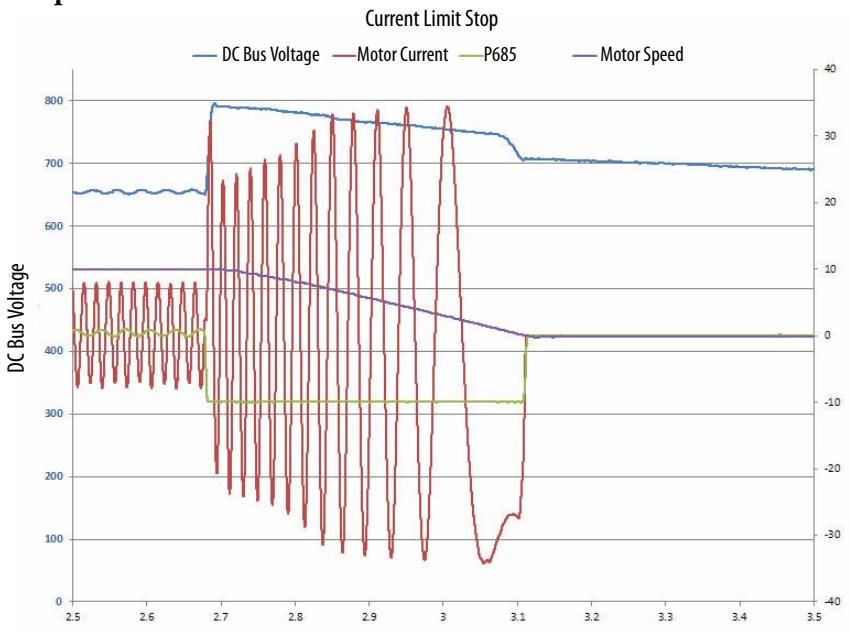
Current Limit Stop



Current Limit stop is not typically set up as the normal Stop mode. Usually the normal stop is programmed at some ramp rate. For the current limit stop a digital input is used for the function. However, you certainly could set the normal stop as CurrentLimit Stop

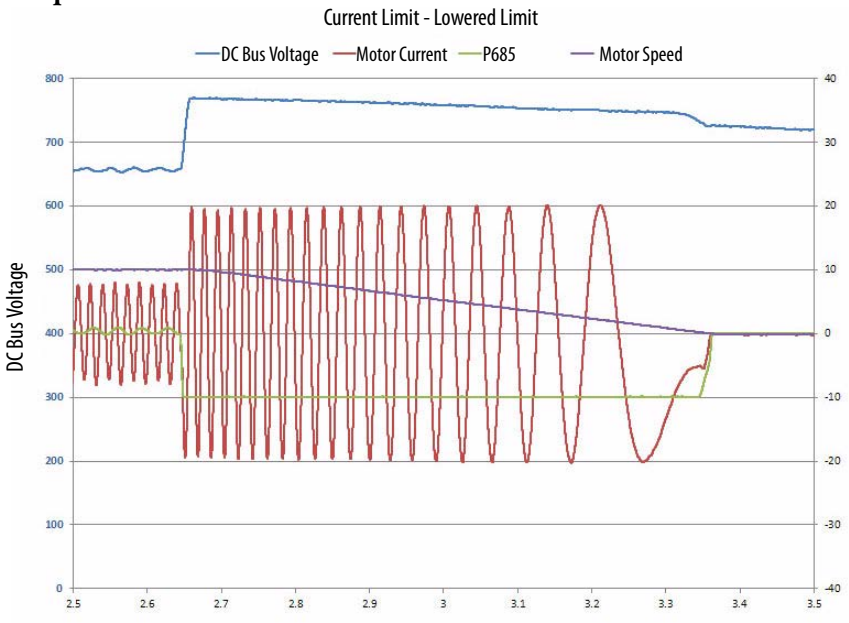
Current limit stop ramp rate is 0.1 second and is not programmable

Example



In this example the current limit was set high enough to allow the full rating of the drive to be used in the stop sequence.

Example



In this example the current limit was set at some value such that when the stop was issued the output current was clamped at that setting. Note the decel time is extended.

Voltage Class

PowerFlex drives are sometimes referred to by voltage class, which identifies the general input voltage to the drive. P305 [Voltage Class] includes a range of voltages. For example, a 400V class drive will have an input voltage range of 380...480V AC. While the hardware remains the same for each class, other variables, such as factory defaults, catalog number and power unit ratings will change. In most cases the voltage of a drive can be reprogrammed to another value within the class by resetting the defaults to something other than factory settings.

P305 [Voltage Class], is required by the drive when parameter downloads occur and is generally not programmed individually. This parameter provides a "Low Voltage" and "High Voltage" setting. The default value is dependent upon the voltage that matches the catalog number (for example 400V or 480V). For example, a drive shipped as 400V (catalog code "C") will have a default of "Low Voltage" for P305 [Voltage Class]. A drive shipped as 480V (catalog code "D") will have a default of "High Voltage."

When a change is made to P305 [Voltage Class], the continuous current rating of the drive will change by an amount equal to the published difference between catalog numbers. With a change to the current rating, P422 [Current Limit 1] and P423 [Current Limit 2] should also be reviewed.

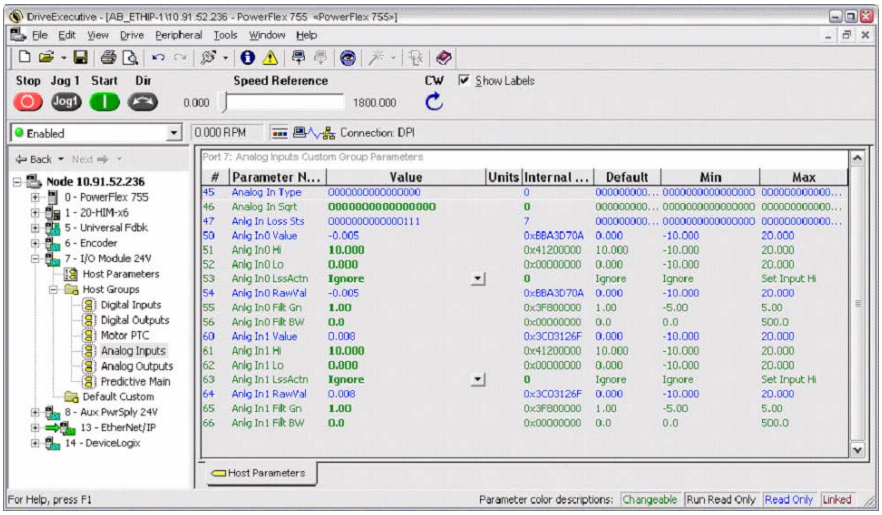
Also note that a Reset to Defaults "All" will reset the voltage to the original factory setting.

Notes:

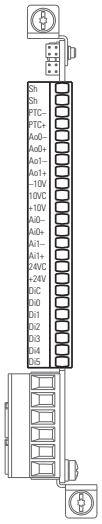
Feedback and I/O

Analog Inputs

There are two analog inputs per I/O module. Up to four I/O modules can be mounted in the drive ports. See the PowerFlex 750-Series Installation Instructions, publication 750-IN001, for valid ports. Accessing the analog input parameters is done by selecting the port in which the module is mounted, then accessing the Analog Input group of parameters.


DriveExecutive - [AB_ETHIP-1\10.91.52.236 - PowerFlex 755 <PowerFlex 755>]
File Edit View Drive Peripheral Tools Window Help
Stop Jog 1 Start Dir
Speed Reference
0.000
1800.000
CW
Show Labels
Enabled
0.000 RPM
Connection: DPI
Node 10.91.52.236
0 - PowerFlex 755
1 - 20-HIM-x6
5 - Universal Fdbk
6 - Encoder
7 - I/O Module 24V
Host Parameters
Host Groups
Digital Inputs
Digital Outputs
Motor PTC
Analog Inputs
Analog Outputs
Predictive Main
Default Custom
8 - Aux PwrSply 24V
13 - EtherNet/IP
14 - DeviceLogix
Port 7: Analog Inputs Custom Group Parameters
Parameter N... Value Units Internal ... Default Min Max
45 Analog In Type 0 0 0
46 Analog In Sqrt 0 0 0
47 Anlg In Loss Sts 7 0 0
50 Anlg In0 Value -0.005 0x88A3D70A 0.000 -10.000 20.000
51 Anlg In0 Hi 10.000 0x41200000 10.000 -10.000 20.000
52 Anlg In0 Lo 0.000 0x00000000 0.000 -10.000 20.000
53 Anlg In0 LssActn Ignore 0 Ignore Ignore Set Input Hi
54 Anlg In0 RawVal -0.005 0x88A3D70A 0.000 -10.000 20.000
55 Anlg In0 Filt Gn 1.00 0x3F800000 1.00 -5.00 5.00
56 Anlg In0 Filt BW 0.0 0x00000000 0.0 0.0 500.0
60 Anlg In1 Value 0.008 0x3C03126F 0.000 -10.000 20.000
61 Anlg In1 Hi 10.000 0x41200000 10.000 -10.000 20.000
62 Anlg In1 Lo 0.000 0x00000000 0.000 -10.000 20.000
63 Anlg In1 LssActn Ignore 0 Ignore Ignore Set Input Hi
64 Anlg In1 RawVal 0.008 0x3C03126F 0.000 -10.000 20.000
65 Anlg In1 Filt Gn 1.00 0x3F800000 1.00 -5.00 5.00
66 Anlg In1 Filt BW 0.0 0x00000000 0.0 0.0 500.0
Host Parameters
For Help, press F1
Parameter color descriptions: Changeable Run Read Only Read Only Linked

Analog Input Specifications



Terminal	Name	Description	Related Param [5]
Sh	Shield	Terminating point for wire shields when an EMC plate or conduit box is not installed.	
Sh			
Ptc–	Motor PTC (–)	Motor protection device (Positive Temperature Coefficient).	40 on Port X
Ptc+	Motor PTC (+)		
Ao0–	Analog Out 0 (–)	Bipolar, ±10V, 11 bit & sign, 2 k ohm minimum load. 4-20 mA, 11 bit & sign, 400 ohm maximum load.	75 on Port X
Ao0+	Analog Out 0 (+)		
Ao1–	Analog Out 1 (–)		85 on Port X
Ao1+	Analog Out 1 (+)		
–10V	–10 Volt Reference	2k ohm minimum.	
10VC	10 Volt Common	For (–) and (+) 10 Volt references.	
+10V	+10 Volt Reference	2k ohm minimum.	
Ai0–	Analog Input 0 (–)	Isolated [3], bipolar, differential, 11 bit & sign. Voltage mode: ±10V @ 88k ohm input impedance. Current mode: 0-20 mA @ 93 ohm input impedance.	50, 70 on Port X
Ai0+	Analog Input 0 (+)		
Ai1–	Analog Input 1 (–)		60, 70 on Port X
Ai1+	Analog Input 1 (+)		
24VC	24 Volt Common [1]	Drive supplied logic input power. 200 mA max per I/O module 600 mA max per drive	
+24V	+24 Volt DC [1]		
Di C	Digital Input Common	Common for Digital Inputs 0…5	
Di 0	Digital Input 0 [2]	24V DC - Opto isolated Low State: less than 5V DC High State: greater than 20V DC 11.2 mA DC 115V AC, 50/60 Hz [4] - Opto isolated Low State: less than 30V AC High State: greater than 100V AC	1 on Port X
Di 1	Digital Input 1 [2]		
Di 2	Digital Input 2 [2]		
Di 3	Digital Input 3 [2]		
Di 4	Digital Input 4 [2]		
Di 5	Digital Input 5 [2]		

(1) Not present on 120V versions.

(2) Digital Inputs are either 24 Volts DC (2262C) or 115 Volts AC (2262D) based on module catalog number. Be sure applied voltage is correct for I/O module.

(3) Differential Isolation - External source must be maintained at less than 160V with respect to PE. Input provides high common mode immunity.

(4) For CE compliance use shielded cable. Cable length should not exceed 30 m (98 ft).

(5) I/O Module parameters will also have a Port designation.

Analog Scaling

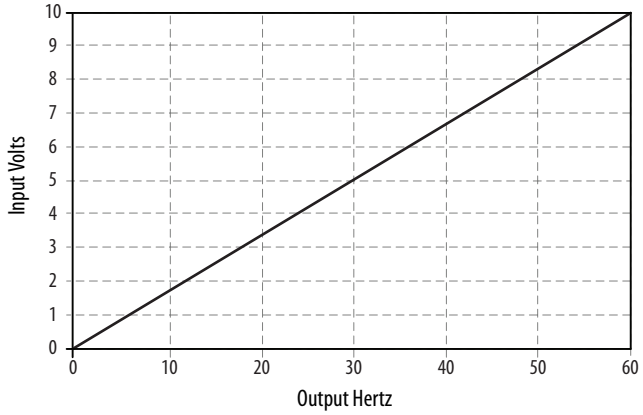
[Anlg In*n* Lo]
[Anlg In*n* Hi]

A scaling operation is performed on the value read from an analog input to convert it to units usable for some particular purpose. Control the scaling by setting parameters that associate a low and high analog value (in volts or mA) with a low and high target (in Hz).

Example 1

- P255 [Anlg In Type], Bit 0 = "0" (Voltage)
- P545 [Spd Ref A Sel] = "Analog In 1"
- P547 [Spd Ref A AnlgHi] = 60 Hz
- P548 [Spd Ref A AnlgLo] = 0 Hz
- P61 [Anlg In1 Hi] = 10V
- P62 [Anlg In1 Lo] = 0V

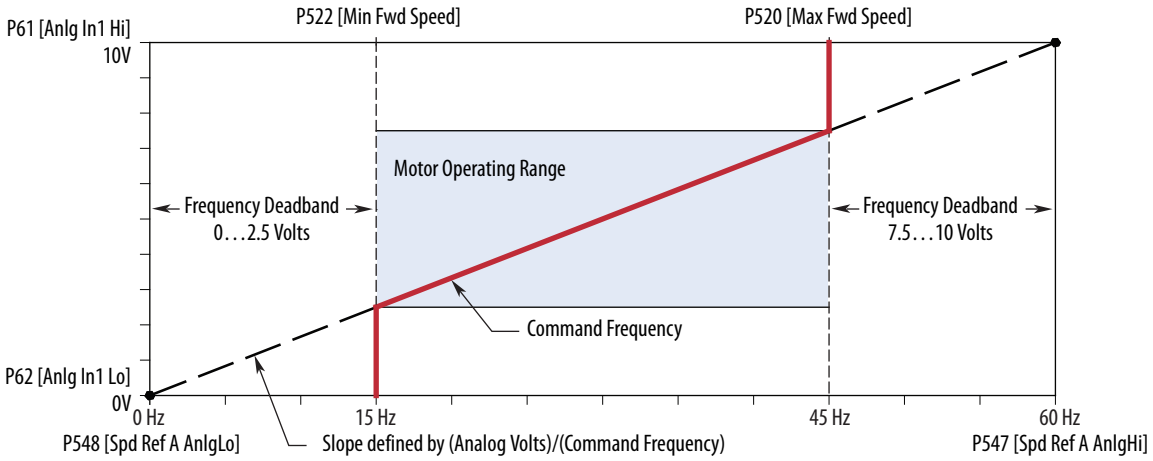
This is the default setting, where 0 volts represents 0 Hz and 10 volts represents 60 Hz providing 1024 steps (10 bit analog input resolution) between 0 and 60 Hz.



Example 2
Consider the following setup:

- P255 [Anlg In Type], Bit 0 = "0" (voltage)
- P545 [Spd Ref A Sel] = "Analog In 1"
- P61 [Anlg In1 Hi] = 10V
- P62 [Anlg In1 Lo] = 0V
- P547 [Spd Ref A AnlgHi] = 60 Hz
- P548 [Spd Ref A AnlgLo] = 0 Hz
- P520 [Max Fwd Speed] = 45 Hz
- P522 [Min Fwd Speed] = 15 Hz

This configuration is used when non-default settings are desired for minimum and maximum speeds, but full range (0...10V) scaling from 0...60 Hz is still desired.



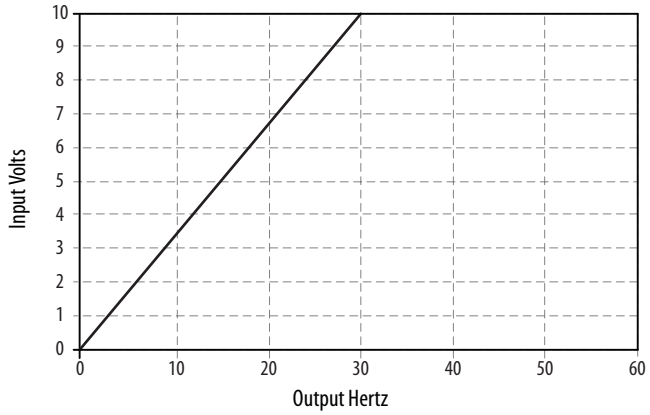
In this example, a deadband from 0...2.5 volts and from 7.5...10 volts is created. Alternatively, the analog input deadband could be eliminated while maintaining the 15 and 45 Hz limits with the following changes:

- P548 [Spd Ref A AnlgLo] = 15 Hz
- P547 [Spd Ref A AnlgHi] = 45 Hz

Example 3

- P255 [Anlg In Type], Bit 0 = "0" (Voltage)
- P545 [Spd Ref A Sel] = "Analog In 1"
- P547 [Spd Ref A AnlgHi] = 30 Hz
- P548 [Spd Ref A AnlgLo] = 0 Hz
- P61 [Anlg In1 Hi] = 10V
- P62 [Anlg In1 Lo] = 0V

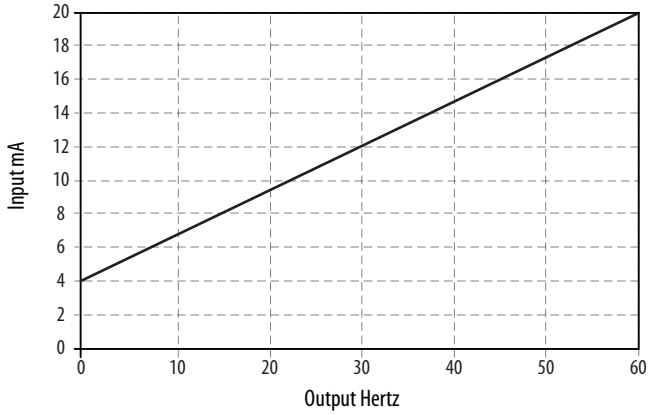
This is an application that requires only 30 Hz as a maximum output frequency but is still configured for full 10 volt input. The result is that the resolution of the input has been doubled, providing 1024 steps between 0 and 30 Hz.



Example 4

- P255 [Anlg In Type], Bit 0 = "1" (Current)
- P545 [Spd Ref A Sel] = "Analog In 1"
- P547 [Spd Ref A AnlgHi] = 60 Hz
- P548 [Spd Ref A AnlgLo] = 0 Hz
- P61 [Anlg In1 Hi] = 20 mA
- P62 [Anlg In1 Lo] = 4 mA

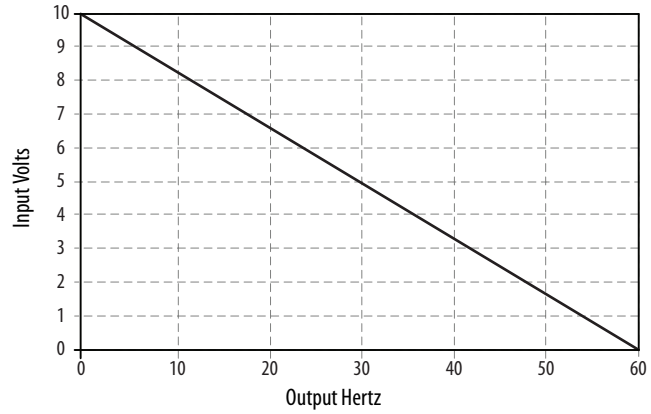
This configuration is referred to as offset. In this case, a 4...20 mA input signal provides 0-60 Hz output, providing a 4 mA offset in the speed command.



Example 5

- P255 [Anlg In Type], Bit 0 = "0" (Voltage)
- P545 [Spd Ref A Sel] = "Analog In 1"
- P547 [Spd Ref A AnlgHi] = 0 Hz
- P548 [Spd Ref A AnlgLo] = 60 Hz
- P61 [Anlg In1 Hi] = 10V
- P62 [Anlg In1 Lo] = 0V

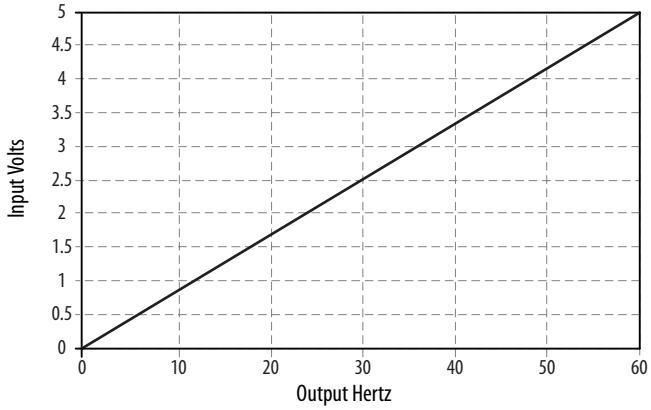
This configuration is used to invert the operation of the input signal. Here, maximum input (10V) represents 0 Hz and minimum input (0V) represents 60 Hz.



Example 6

- P255 [Anlg In Type], Bit 0 = "0" (Voltage)
- P545 [Spd Ref A Sel] = "Analog In 1"
- P547 [Spd Ref A AnlgHi] = 60 Hz
- P548 [Spd Ref A AnlgLo] = 0 Hz
- P61 [Anlg In1 Hi] = 5V
- P62 [Anlg In1 Lo] = 0V

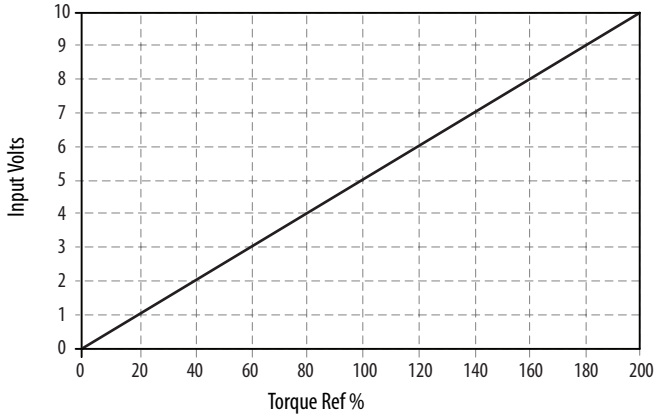
This configuration is used when the input signal is 0...5V. Here, minimum input (0V) represents 0 Hz and maximum input (5V) represents 60 Hz. This allows full scale operation from a 0...5V source.



Example 7

- P255 [Anlg In Type], Bit 0 = "0" (Voltage)
- P675 [Trq Ref A Sel] = "Analog In 1"
- P677 [Trq Ref A AnlgHi] = 200%
- P678 [Trq Ref A AnlgLo] = 0%

This configuration is used when the input signal is 0...10V. The minimum input of 0V represents a torque reference of 0% and maximum input of 10V represents a torque reference of 200%.



Square Root

The square root function can be applied to each analog input through the use of [Analog In Sq Root]. The function should be enabled if the input signal varies with the square of the quantity (for example drive speed) being controlled.

If the mode of the input is bipolar voltage (-10...10V), then the square root function will return 0 for all negative voltages.

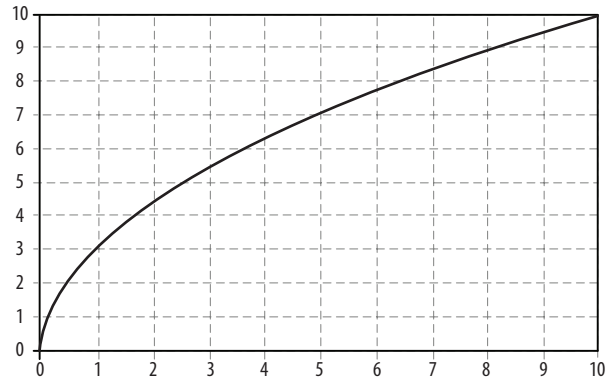
The function uses the square root of the analog value as compared to its full scale (for example $5V = 0.5$ or 50% and $\sqrt{0.5} = 0.707$) and multiplies it times the full scale of what it will control (for example 60 Hz).

The complete function can be describes as follows:

$$\left(\sqrt{\frac{\text{Analog Value - [Analog In x Lo]}}{\text{[Analog In x Hi] - [Analog In x Lo]}}}\right) \times \left(\text{[Speed Ref A Hi]} - \text{[Speed Ref A Lo]}\right) + \text{[Speed Ref A Lo]}$$

Setting high and low values to 0V, 10V, 0 Hz, and 60 Hz, the expression reduces to the following:

$$\left(\sqrt{\frac{\text{Analog Value}}{\text{10V}}}\right) \times \text{60 Hz}$$



Analog Input Loss Detection

Signal loss detection can be detected for each analog input. P47 [Anlg In Loss Sts] bits 0, 1, 2 will indicate if the signal is lost. Bit 0 indicates that one or both signals are lost. P53 [Anlg In0 LssActn] and P63 [Anlg In1 LssActn] defines what action the drive will take when loss of any analog input signal occurs.

Selects drive action when an analog signal loss is detected. Signal loss is defined as an analog signal less than 1V or 2 mA. The signal loss event ends and normal operation resumes when the input signal level is greater than or equal to 1.5V or 3 mA.

- "Ignore" (0) – No action is taken.
- "Alarm" (1) – Type 1 alarm indicated.
- "Flt Minor" (2) – Minor fault indicated. If running, drive continues to run. Enable with P950 [Minor Flt Cfg]. If not enabled, acts like a major fault.
- "FltCoastStop" (3) – Major fault indicated. Coast to Stop.
- "Flt RampStop" (4) – Major fault indicated. Ramp to Stop.
- "Flt CL Stop" (5) – Major fault indicated. Current Limit Stop.
- "Hold Input" (6) – Holds input at last value.
- "Set Input Lo" (7) – Sets input to P52 [Anlg In0 Lo] or P62 [Anlg In1 Lo].
- "Set Input Hi" (8) – Sets input to P51 [Anlg In0 Hi] or P61 [Anlg In1 Hi].

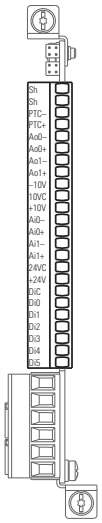
If the input is in Current mode, 4 mA is the normal minimum usable input value. Any value below 3.2 mA will be interpreted by the drive as a signal loss, and a value of 3.8 mA will be required on the input for the signal loss condition to end.

If the input is in Unipolar Voltage mode, 2V is the normal minimum usable input value. Any value below 1.6V will be interpreted by the drive as a signal loss, and a value of 1.9V will be required on the input for the signal loss condition to end. No signal loss detection is possible while an input is in Bipolar Voltage mode. The signal loss condition will never occur even if signal loss detection is enabled.

Analog Outputs

There are two analog outputs per I/O module. Up to five I/O modules can be mounted in the drive ports. See 750-IN001 for valid ports. Accessing the analog output parameters is done by selecting the port in which the module is mounted then accessing the Analog Output group of parameters.

Analog Output Specifications



Terminal	Name	Description	Related Param (5)
Sh	Shield	Terminating point for wire shields when an EMC plate or conduit box is not installed.	
Sh			
Ptc–	Motor PTC (–)	Motor protection device (Positive Temperature Coefficient).	40 on Port X
Ptc+	Motor PTC (+)		
Ao0–	Analog Out 0 (–)	Bipolar, ±10V, 11 bit & sign, 2 k ohm minimum load. 4-20 mA, 11 bit & sign, 400 ohm maximum load.	75 on Port X
Ao0+	Analog Out 0 (+)		
Ao1–	Analog Out 1 (–)		85 on Port X
Ao1+	Analog Out 1 (+)		
–10V	–10 Volt Reference	2k ohm minimum.	
10VC	10 Volt Common	For (–) and (+) 10 Volt references.	
+10V	+10 Volt Reference	2k ohm minimum.	
Ai0–	Analog Input 0 (–)	Isolated (3), bipolar, differential, 11 bit & sign. Voltage mode: ±10V @ 88k ohm input impedance. Current mode: 0-20 mA @ 93 ohm input impedance.	50, 70 on Port X
Ai0+	Analog Input 0 (+)		
Ai1–	Analog Input 1 (–)		60, 70 on Port X
Ai1+	Analog Input 1 (+)		
24VC	24 Volt Common (1)	Drive supplied logic input power. 200 mA max per I/O module 600 mA max per drive	
+24V	+24 Volt DC (1)		
Di C	Digital Input Common	Common for Digital Inputs 0 . . . 5	
Di 0	Digital Input 0 (2)	24V DC - Opto isolated Low State: less than 5V DC High State: greater than 20V DC 11.2 mA DC 115V AC, 50/60 Hz (4) - Opto isolated Low State: less than 30V AC High State: greater than 100V AC	1 on Port X
Di 1	Digital Input 1 (2)		
Di 2	Digital Input 2 (2)		
Di 3	Digital Input 3 (2)		
Di 4	Digital Input 4 (2)		
Di 5	Digital Input 5 (2)		

(1) Not present on 120V versions.

(2) Digital Inputs are either 24 Volts DC (2262C) or 115 Volts AC (2262D) based on module catalog number. Be sure applied voltage is correct for I/O module.

(3) Differential Isolation - External source must be maintained at less than 160V with respect to PE. Input provides high common mode immunity.

(4) For CE compliance use shielded cable. Cable length should not exceed 30 m (98 ft).

(5) I/O Module parameters will also have a Port designation.

Analog Output Configuration

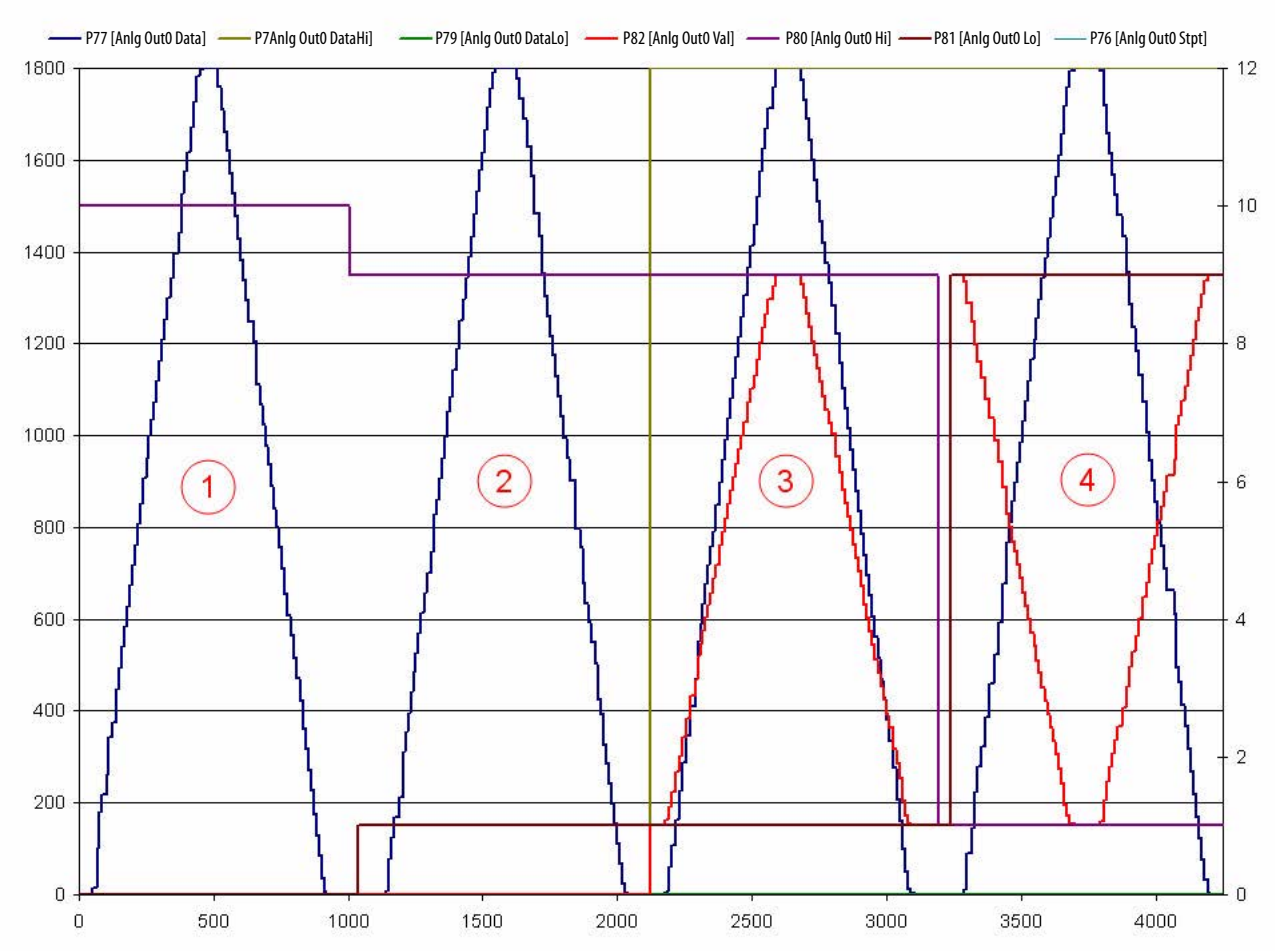
Parameters 75 and 85 [Anlg Out*n* Select] are use to specify the signal used on Analog Outputs 1 and 2, respectively. These parameters can be programmed to the following selections.

Parameter	Selection
1	Output Frequency
2	Commanded Speed Ref
3	Motor Velocity Feedback
4	Commanded Torque
5	Torque Current Feedback
6	Flux Current Feedback
7	Output Current
8	Output Voltage
9	Output Power
11	DC Bus Voltage

Scaling

The scaling for the analog output is defined by entering analog output voltages into two parameters, [Analog Out1 Lo] and [Analog Out1 Hi]. These two output voltages correspond to the bottom and top of the possible range covered by the quantity being output. Scaling of the analog outputs is accomplished with low and high analog parameter settings that are associated with fixed ranges (see programming manual) for each target function. Additionally, the PowerFlex 755 contains an adjustable scale factor to override the fixed target range. P77 [Anlg Outx Data] and 82 [Anlg Outx Val] are described in the charts below.

Case 1



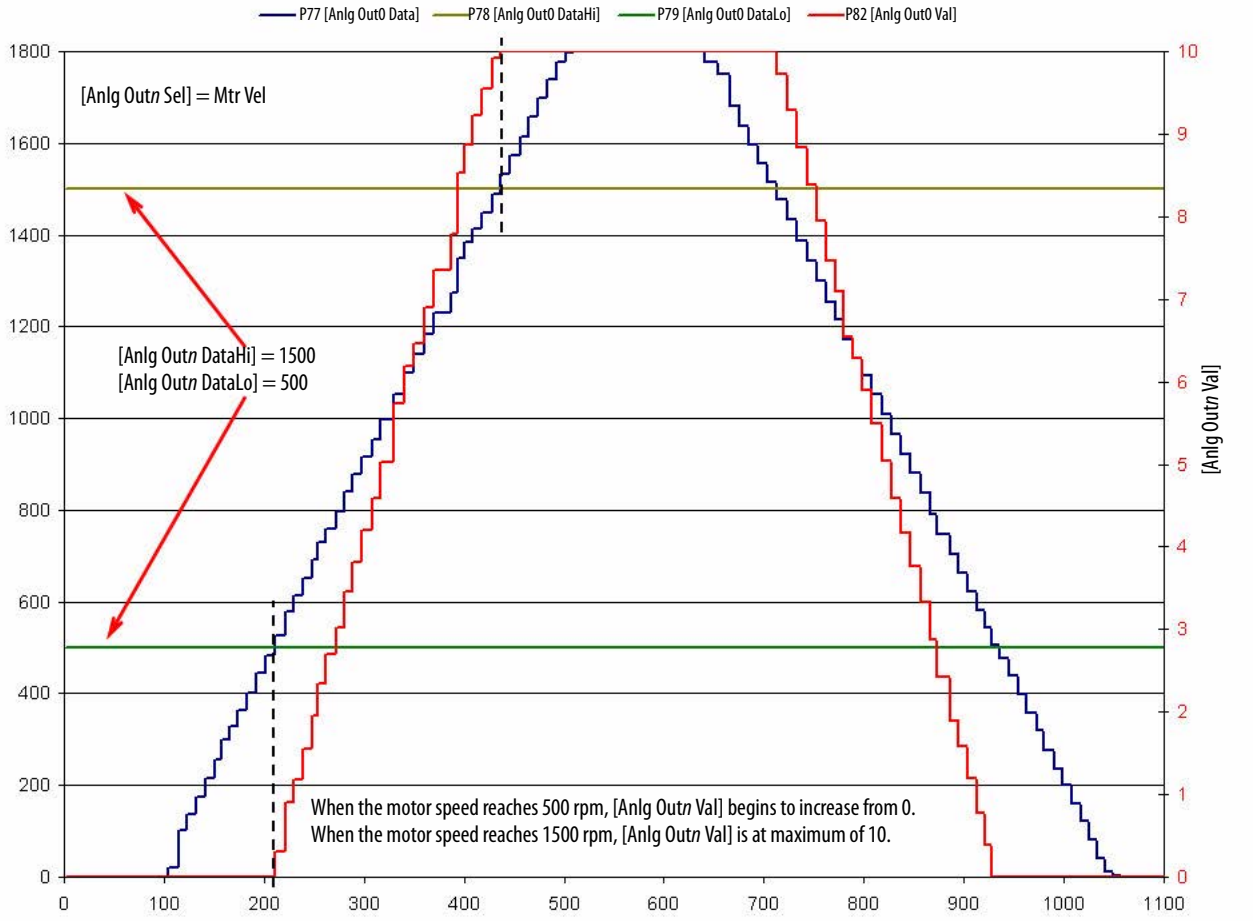
Section 1: This shows P77 [Anlg Out*n* Data] the units will be consistent with the selection of [Anlg Out*n* Select]. In this case the analog out select is set to Mtr Vel Fdbk. So the units are in rpm. [Anlg Out*n* Hi], [Anlg Out*n* Lo], [Anlg Out*n* DataHi] and [Anlg Out*n* DataLo] are all at default. The motor was started and ramped to 1800 rpm. Note that [Anlg Out*n* Val] remained zero.

Section 2: Here the [Anlg Out*n* Hi] was changed to 9 and [Anlg Out*n* Lo] was changed to 1. As the motor ramps up and down, there is no change in the value or scaling of [Anlg Out*n* Data]. Note that [Anlg Out*n* Val] is still zero.

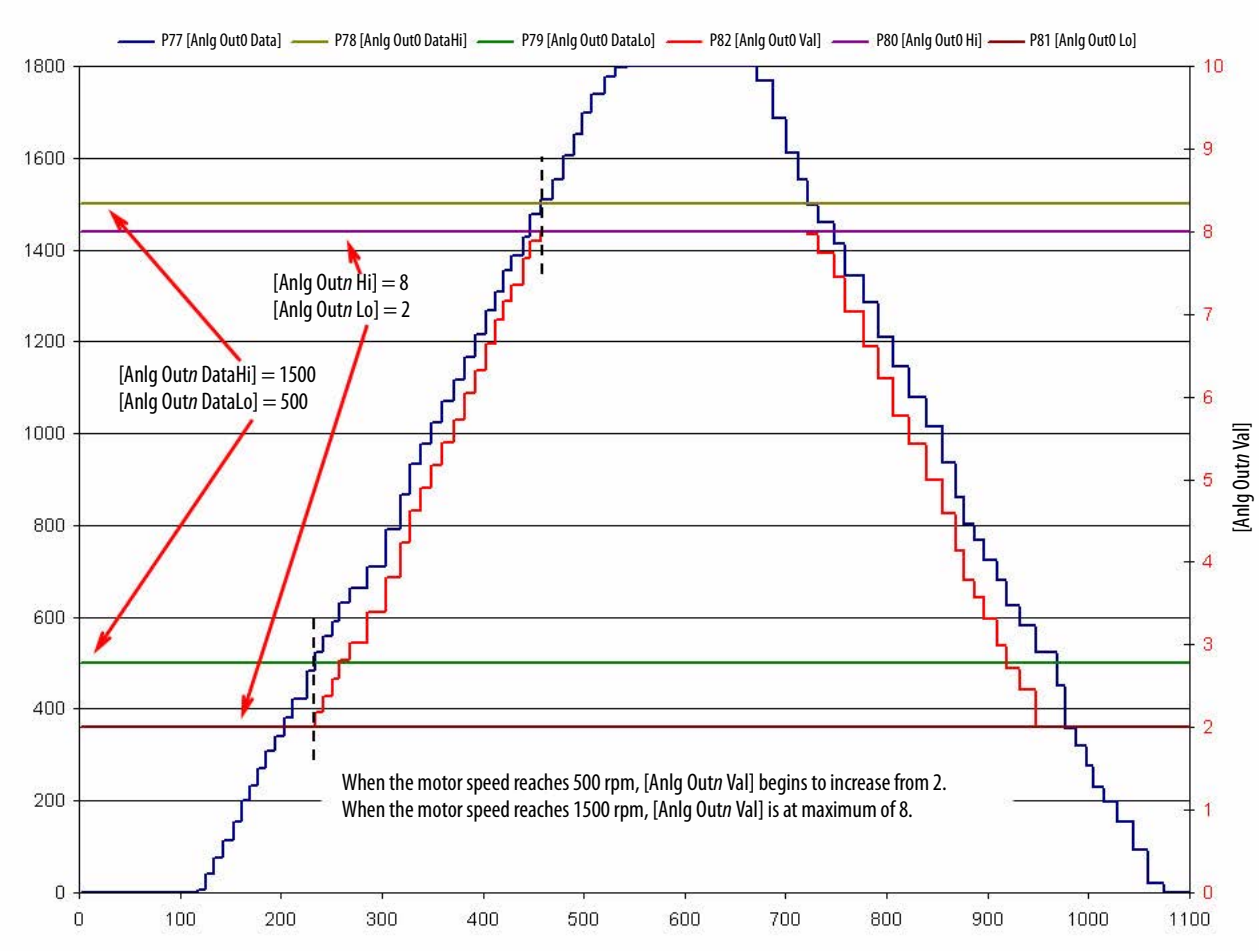
Section 3: Now the [Anlg Out*n* DataHi] was changed to 1800 and [Anlg Out*n* DataLo] left at zero. When started [Anlg Out*n* Val] starts at 1 and reaches 9 when the motor speed is at maximum.

Section 4: In this section the [Anlg Out*n* Hi] and [Anlg Out*n* Lo] were reversed in value. Now when the motor ramps up and down [Anlg Out*n* Val] is just the opposite. It starts out at 9 and is at 1 at full speed.

Case 2


P77 [Anlg Out0 Data]
P78 [Anlg Out0 DataHi]
P79 [Anlg Out0 DataLo]
P82 [Anlg Out0 Val]
[Anlg Outn Sel] = Mtr Vel
[Anlg Outn DataHi] = 1500
[Anlg Outn DataLo] = 500
When the motor speed reaches 500 rpm, [Anlg Outn Val] begins to increase from 0.
When the motor speed reaches 1500 rpm, [Anlg Outn Val] is at maximum of 10.
[Anlg Outn Val]
1800
1600
1400
1200
1000
800
600
400
200
0
10
9
8
7
6
5
4
3
2
1
0
0
100
200
300
400
500
600
700
800
900
1000
1100

Case 3

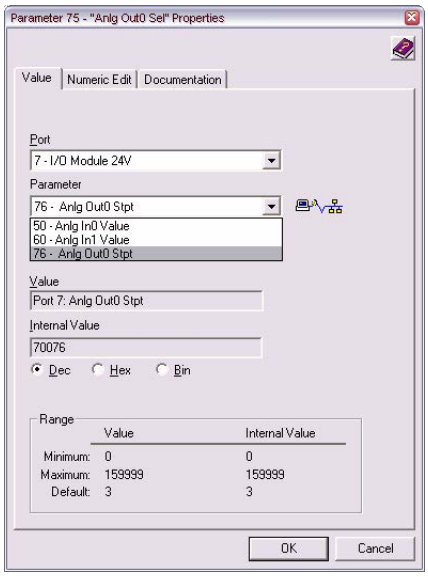


Absolute (Default)

Certain quantities used to drive the analog output are signed, for example the quantity can be both positive and negative. You have the option of having the absolute value (value without sign) of these quantities taken before the scaling occurs. Absolute value is enabled separately for each analog output via the bit enumerated P71 [Analog Out Abs].

Setpoint

Setpoint is a possible source for an analog output. It can be used to control an analog output from a communication device using a DataLink. Change P75 [Anlg Outx Sel] to 76 [Anlg Outx Stpt]. Then map a datalink to P76 and you'll be able to drive the analog output over a network.



Digital Inputs

Physical inputs are programmed to desired digital input functions. These parameters cannot be changed while the drive is running.

Technical Information

The PowerFlex 753 drive has a total of three digital inputs located on its main control board:

- Di0 – Configured for 115 VAC or 24 VDC
  - Shared common (DiC) between Di0ac and Di0dc terminals
  - Located on TB3 - bottom of the main control board
- Di1 and Di2 – Configured for 24 VDC
  - Shared common (DiC) for Di1 and Di2
  - Located on TB1 - lower front of the main control board

PowerFlex 753 Main Control Board I/O TB1 wiring examples are included in the PowerFlex 750-Series AC Drives Installation Instructions, publication 750-IN001.

The PowerFlex 755 drive has a total of one digital input located on its main control board:

- Di0 – configured for 115 VAC or 24 VDC
  - Shared common (DiC) between Di0ac and Di0dc terminals
  - Located on TB1 - bottom of the main control board

There are also PowerFlex 750-Series option modules that expand the amount of digital inputs that can be used in both the PowerFlex 753 and 755 drives.

20-750-2262C-2R / 20-750-2263C-1R2T

- Six 24 VDC input terminals:
  - Labeled as Di0, Di1, Di2, Di3, Di4 and Di5
  - Shared common (DiC)
  - Located on TB1 - front of the option module

20-750-2262D-2R

- Six 115 VAC input terminals:
  - Labeled as Di0, Di1, Di2, Di3, Di4 and Di5
  - Shared common terminal (DiC)
  - Located on TB1 - front of the option module

PowerFlex 750-Series Option Modules I/O TB1 wiring examples are included in the PowerFlex 750-Series AC Drives Installation Instructions, publication 750-IN001.

Configuration

Digital inputs can be programmed to a desired function defined by Parameters 155 to 201 below. These parameters cannot be changed while the drive is running.

Number	Parameter Name	Number	Parameter Name	Number	Parameter Name
155	DI Enable	170	DI Jog 2 Forward	187	DI PwrLoss ModeB
156	DI Clear Fault	171	DI Jog 2 Reverse	188	DI Pwr Loss
157	DI Aux Fault	172	DI Manual Ctrl	189	DI Precharge
158	DI Stop	173	DI Speed Sel 0	190	DI Prchrg Seal
159	DI Cur Lmt Stop	174	DI Speed Sel 1	191	DI PID Enable
160	DI Coast Stop	175	DI Speed Sel 2	193	DI PID Hold
161	DI Start	176	DI HOA Start	193	DI PID Reset
162	DI Fwd Reverse	177	DI MOP Inc	194	DI PID Invert
163	DI Run	178	DI MOP Dec	195	DI Torque StptA
164	DI Run Forward	179	DI Accel 2	196	DI Fwd End Limit
165	DI Run Reverse	180	DI Decel 2	197	DI Fwd Dec Limit
166	DI Jog 1	181	DI SqTqPs Sel 0	198	DI Rev End Limit
167	DI Jog 1 Forward	182	DI SqTqPs Sel 1	199	DI Rev Dec Limit
168	DI Jog 1 Reverse	185	DI Stop Mode B	200	DI PHdwr OvrTrvl
169	DI Jog 2	186	DI BusReg Mode B	201	DI NHdwr OvrTrvl

Operation for DI Run type parameters can be defined by P150 [Digital In Cfg]:

- "Run Edge" (0) – Control function requires a rising edge (open to close transition) for the drive to run.
- "Run Level" (1) – As long as a separate "Stop" command is not issued, the level alone (no rising edge required) determines whether the drive will run. When set to 1 "Run Level" the absence of a run command is indicated as a stop asserted and P935 [Drive Status 1] Bit 0 will be low.

ATTENTION: Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations, or industry guidelines.

Functional Descriptions

DI Enable
Closing this input allows the drive to run when a Start command is issued. If the drive is already running when this input is opened, the drive will coast stop and indicate "not enabled" on the HIM (if present). This is not considered a fault condition, and no fault will be generated. If this function is not configured, the drive is considered enabled.

IMPORTANT If the ENABLE (J1) jumper is removed, the Di0 becomes a hardware enable. For the PowerFlex 753, Di0 is found on TB3 and for the PowerFlex 755, Di0 is found on TB1.

A combination of the hardware enable and a software enable may be utilized; however, the drive will not run if any of the inputs are open.

DI Clear Fault
The "Clear Fault" digital input function allows an external device to reset drive faults through the terminal block. An open to closed transition on this input will cause an active fault (if any) to be reset.

DI Aux Fault
This input function is normally closed and allows external equipment to fault the drive. When this input opens, the drive will fault with the "Auxiliary Input" (F2) fault code. If this input function is not configured, then the fault will not occur.

DI Stop
An open input will cause the drive to stop and become "Not Ready." A closed input will allow the drive to run when given a Start or Run command. If "Start" is configured, then "Stop" must also be configure, otherwise, a digital input configuration alarm will occur.

P370 [Stop Mode A] and P371 [Stop Mode B] will dictate the drive's stop action. Refer to Stop Modes on page 74 for more details.

DI Cur Lmt Stop
With this digital input function, an open input will cause the drive to current limit stop. The drive acknowledges the stop command by setting the motor speed reference to zero, causing the drive to bring the motor down to zero speed as fast as the power limits, torque limits and current limits will allow. When the drive output reaches zero, the output transistors are shut off.

DI Coast Stop
With this digital input function, an open input will cause the drive to Coast-to-Stop. The drive acknowledges the stop command by shutting off the output transistors and releasing control of the motor. The load/motor will coast or free spin until the mechanical energy is dissipated.

DI Start
An open to closed transition while the drive is stopped will cause the drive to run in the current direction, unless the "Stop" input function is open. If "Start" is configured, then a "Stop" must also be configured.

DI Fwd Reverse
This digital input function is one of the ways to provide direction control when the "Start" or "Run" functions (not combined with direction) are used. An open input sets direction to forward. A closed input sets direction to reverse. If state of input changes and drive is running or jogging, drive will change direction.

DI Run Forward, DI Run Reverse
These digital input functions cause the drive to run and with a specific direction, as long as the configured input is held closed. Also, these "2-wire" settings prevent any other connected device from starting the drive. An open to closed transition on one input or both inputs while the drive is stopped will cause the drive to run unless the "Stop" input function is configured and open.

The table below describes the basic action taken by the drive in response to particular states of these input functions.

Run Forward	Run Reverse	Action
Open	Open	Drive stops, terminal block relinquishes direction ownership.
Open	Closed	Drive runs in reverse direction, terminal block takes direction ownership.
Closed	Open	Drive runs in forward direction, terminal block takes direction ownership.
Closed	Closed	Drive continues to run in current direction, but terminal block maintains direction ownership.

It is not necessary to program both "Run Forward" and "Run Reverse." These two functions will operate with or without each other.

IMPORTANT Direction control is an "Exclusive Ownership" function (see Owners). This means that only one control device (terminal block, DPI device, HIM, and so forth) at a time is allowed to control direction at a time. The terminal block must become direction "owner" before it can be used to control direction. If another device is currently the direction owner (as indicated by P922 [Dir Owner]), it will not be possible to start the drive or change direction by using the terminal block digital inputs programmed for both Run and Direction control (for example Run/Fwd).

DI Run
This digital input function is similar to "Run Forward" and "Run Reverse" settings. The only difference being that direction is determined by another input or another device's command (HIM or communication adapter).

DI Jog 1 Forward, DI Jog 1 Reverse, DI Jog 2 Forward, DI Jog 2 Reverse
Jog is a non-latched command such as Run, but overrides the normal speed reference and uses P556 [Jog Speed 1] or P557 [Jog Speed 2] respectively.

An open to closed transition on one input or both inputs while the drive is stopped will cause the drive to jog unless the "Stop" input function is configured

and open. The table below describes the actions taken by the drive in response to various states of these input functions.

Jog Forward	Jog Reverse	Action
Open	Open	Drive will stop if already jogging, but can be started by other means. Terminal block relinquishes direction ownership.
Open	Closed	Drive jogs in reverse direction. Terminal block takes direction ownership.
Closed	Open	Drive jogs in forward direction. Terminal block takes direction ownership.
Closed	Closed	Drive continues to jog in current direction, but terminal block maintains direction ownership.

The drive will not jog while the drive is running or while the "Stop" input is open. Start has precedence.

DI Jog 1, DI Jog 2
These digital input functions are similar to "Jog Forward" and "Jog Reverse" with the only difference being that direction is determined by another input or another device's command (HIM or communication adapter). In addition, these settings will use either P556 [Jog Speed 1] or P557 [Jog Speed 2], respectively. In Unipolar mode, the absolute value will be used along with a separate direction command. In Bipolar mode, the polarity of P556 [Jog Speed 1] or P557 [Jog Speed 2] will determine the direction of jog.

DI Manual Ctrl
The digital input function works in conjunction with the overall Auto/Manual function. When this input is closed, it overrides other speed references, but only if another device (HIM) did not have ownership of the Manual state. If the digital input is successful in gaining manual control, the speed reference comes from P563 [DI ManRef Sel], which can be set to any of the Analog Inputs, Preset Speeds, MOP Reference, or an applicable Port Reference.

Associated with this digital input function, there is the ability to configure the drive to switch smoothly from an automatic (communicated) speed reference to manual speed reference produced by the Human Interface Module (HIM). When the drive is commanded to switch from the automatic (communicated) speed reference to the manual reference via a digital input, it preloads the last value from the speed feedback into the HIM. Then the operator can modify the manual reference on the HIM. This avoids a step change in speed that would otherwise occur from the switch. Use this feature by configuring P328 [Alt Man Ref Sel], P331 [Manual Preload], P172 [DI Manual Ctrl], and P563 [DI ManRef Sel]. This feature requires revision 2.001 of 20-HIM-A6 firmware or later.

DI Speed Sel 0, 1, and 2
These digital input functions can be used to select the speed reference. The open/closed state of all the speed select digital input functions combine to select which source is the speed reference.

DI Speed Sel 2	DI Speed Sel 1	DI Speed Sel 0	Auto Reference Source (Parameter)
0	0	0	Reference A (P545)
0	0	1	Reference A (P545)
0	1	0	Reference B (P550)
0	1	1	Preset Speed 3 (P573)
1	0	0	Preset Speed 4 (P574)
1	0	1	Preset Speed 5 (P575)
1	1	0	Preset Speed 6 (P576)
1	1	1	Preset Speed 7 (P577)

Refer to Speed Reference on page 171 for more details.

DI HOA Start
This digital input function that allows for Hand-Off-Auto control. It functions like a three-wire start signal; with the exception, that it does not require the DI Stop to be high for a full input cycle before the drive looks for a rising edge on DI HOA Start. Use this feature by configuring P176 [DI HOA Start].

DI MOP Inc, DI MOP Dec
These digital input functions are used to increment and decrement the Motor Operated Potentiometer (MOP) value inside the drive. The MOP is a reference value that can be incremented and decremented by external devices. The MOP value has a configurable preload and will be retained through a power cycle. For the drive to use the MOP value as the current speed reference, either P545 [Speed Ref A Sel], P550 [Speed Ref B Sel], or P563 [DI ManRef Sel] must be set to "MOP Reference."

DI Accel 2, DI Decel 2
These digital input functions toggle between primary and secondary ramp rates. For example, with a digital input programmed to P179 [DI Accel 2], an open digital input follows P535 [Accel Time 1]. A closed digital input follows P536 [Accel Time 2].

DI SpTqPs Sel 0 and 1
These digital input functions provide the ability to switch between different Speed/Torque/Position modes, (P309 [SpdTrqPsn Mode A], P310 [SpdTrqPsn Mode B], P311 [SpdTrqPsn Mode C], and P312 [SpdTrqPsn Mode D]) from digital input combinations. See Speed Torque Position on page 182 for a complete description of these modes and the digital input combinations that activate each mode.

DI Stop Mode B
This digital input function selects between two different drive Stop modes. If the input is open, then P370 [Stop Mode A] selects which Stop mode to use. If the input is closed, then P371 [Stop Mode B] selects which Stop mode to use. If this input function is not configured, then P370 [Stop Mode A] always selects which Stop mode to use. See also Stop Modes on page 74 for more details.

DI BusReg Mode B
This digital input function selects how the drive will regulate excess voltage on the DC bus. If the input is open, then P372 [Bus Reg Mode A] selects which bus regulation mode to use. If the input is closed, then P373 [Bus Reg Mode B] selects which bus regulation mode to use. If this input function is not configured, then P372 [Bus Reg Mode A] always selects which bus regulation mode to use. See also Bus Regulation on page 30 for more details.

DI PwrLoss ModeB
This digital input function selects between two different drive power loss modes. If the input is open, P450 [Power Loss Mode A] dictates the drive's action during the Power Loss mode. If the input is closed, P371 [Stop Mode B] dictates the drive's action during the power loss. If this input function is not configured, then P450 [Power Loss Mode A] will always dictate the drive's action during the power loss. See also Power Loss on page 62 for more details.

DI Pwr Loss
The drive contains a sophisticated algorithm to manage initial application of power as well as recovery from a partial power loss event. This digital input function is used to force the drive into a power loss condition. If this input is open, the drive's internal algorithm dictates the power loss condition. If the input is closed, the algorithm is overridden and the drive is externally forced into a power lost condition. P449 [Power Loss Actn] configures the drive's response to a power loss time out condition and P452 [Pwr Loss Mode A] or P455 [Pwr Loss Mode B] will set the time that the drive will remain in Power Loss mode before a fault occurs. See also Power Loss on page 62 for more details.

DI Precharge
This digital input function is used to manage disconnection from a common DC bus. If the input is closed, this indicates that the drive is connected to common DC bus and normal precharge handling can occur, and that the drive can run (start permissive). If the physical input is open, this indicates that the drive is disconnected from the common DC bus, and thus the drive should enter the precharge state and initiate a coast stop immediately to prepare for reconnection to the bus. If this input function is not configured, then the drive assumes that it is always connected to the DC bus, and no special precharge handling will be done.

DI Prchrg Seal
This digital input function is used to force a unique fault when an external precharge circuit opens. P323 [Prchrg Err Cfg] dictates the action taken when an external precharge circuit has opened.

DI PID Enable
If this digital input function is closed, the operation of the Process PID loop will be enabled. If this input function is open, the operation of the Process PID loop will be disabled.

DI PID Hold
If this input function is closed, the integrator for the Process PID loop will be held at the current value. If this input function is open, the integrator for the Process PID loop will be allowed to increase.

DI PID Reset
If this input function is closed, the integrator for the Process PI loop will be reset to 0. If this input function is open, the integrator for the Process PI loop will integrate normally.

DI PID Invert
If this input function is closed, the PI Error is inverted. If this input function is open, the PI Error is not inverted.

DI Torque StptA
This digital input function is used to force P676 [Trq Ref A Stpt] as the source for Torque Reference A, regardless of the setting in P675 [Trq Ref A Sel]. Used when the drive is in a mode that is commanding torque. Refer to P309 [SpdTrqPsn Mode A], P310 [SpdTrqPsn Mode B], P311 [SpdTrqPsn Mode C], and P312 [SpdTrqPsn Mode D].

DI Fwd End Limit, DI Rev End Limit
These digital input functions are used to trigger a Forward End Limit and/or a Reverse End Limit. The resulting action depends on whether the drive is operating as a speed, torque or position regulator. The mode of operation is indicated by P935 [Drive Status 1] Bit 21 "Speed Mode," Bit 22 "PositionMode," and Bit 23 "Torque Mode." When the drive is operating as a speed regulator, the resulting action is to execute a "Fast Stop" command. After the drive stops in this case, it will only restart in the opposite direction (if given a new start command). This function is usually used with a limit switch near the point at which the drive should stop. When the drive is operating as a torque regulator, the resulting action is to execute a "Fast Stop" command. After the drive stops in this case, it will restart and continue operation (if given a new start command). When the drive is operating as a position regulator, the resulting action is to execute a "Fast Stop" command. After the drive stops in this case, it will restart and continue to move towards the position reference (if given a new start command).

DI Fwd Dec Limit, DI Rev Dec Limit
These digital input functions are used to trigger a Forward Decel Limit and/or a Reverse Decel Limit. The resulting action depends on whether the drive is operating as a speed, torque or position regulator. The mode of operation is indicated by P935 [Drive Status 1] Bit 21 "Speed Mode," Bit 22 "PositionMode" and Bit 23 "Torque Mode." When the drive is operating as a speed regulator, the resulting action is to override the speed reference and decelerate to Preset Speed 1. This function is usually used with a limit switch and initiates the slowing down process prior to encountering the End Limit. When the drive is operating as a torque regulator, the drive ignores this signal and continues operating at its torque reference. When the drive is operating as a position regulator, the drive ignores this signal and continues moving towards its position reference.

DI PHdwr OvrTrvl, DI NHdwr OvrTrvl
These digital input functions are used to trigger a Positive Hardware Over-travel and/or a Negative Hardware Over-travel. The resulting action is to immediately fault and produce zero torque. After the drive is stopped, the condition will need to be cleared and the fault will need to be reset. The drive will restart (if given a new start command), and continue operation. It will follow any speed reference, position reference or torque reference. The drive's direction is not modified or limited after the restart. This function is usually used with a limit switch in a position beyond the "End Limit," as an extra safety limit to prevent torque from damaging the machine in an over-travel situation.

Status
For the PowerFlex 753 main control board Digital Inputs (Di) 0, 1, and 2, P220 "Dig In Sts" bits 0, 1 and 2 represents its respective inputs status. For the PowerFlex 755 main control board Digital Inputs (Di) 0, P220 "Dig In Sts" Bit 0 represents its respective digital input status. For the PowerFlex 750-Series Option Module Digital Inputs (Di) 0, 1, 2, 3, 4, and 5, P1 "Dig In Sts" bits 0, 1, 2, 3, 4, and 5 represents its respective digital input status. When the bit associated with the digital input is on, depicted by a 1, this means that the drive recognizes that the digital input is on. When the bit associated with the digital input is off, represented by a 0, this means that the drive recognizes that the digital input is off.

Configuration Conflicts
If you configure the digital inputs so that one or more selections conflict with each other, one of the digital input configuration alarms will be asserted. As long as the Digital Input Conflict exists, the drive will not start. These alarms will be automatically cleared by the drive as soon as the parameters are changed to remove the conflicts. These are examples of configurations that cause an alarm:

- Configuring both the "Start" input function and the "Run Forward" input function at the same time. "Start" is used only in "3-wire" Start mode, and "Run Forward" is used only in "2-wire" Run mode, so they should never be configured at the same time.
- Configuring the same toggle input function (for instance "Fwd Reverse") to more than one physical digital input simultaneously.

These alarms, called Type 2 Alarms, are different from other alarms in that it will not be possible to start the drive while the alarm is active. It should not be possible for any of these alarms to occur while the drive is running, because all digital input configuration parameters can be changed only while the drive is stopped. Whenever one or more of these alarms is present, the drive ready status will become "not ready" and the HIM will reflect a conflict message. In addition, the drive status light will be flashing yellow. Refer to the PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001, for a complete list of Type 2 Alarms.

DigIn Cfg B
Digital input conflict. Input functions that cannot exist at the same time have been selected. Correct Digital Input configuration.

DigIn Cfg C
Digital input conflict. Input functions that cannot be assigned to the same digital input have been selected. Correct Digital Input configuration.

Block Diagrams

Figure 8 - PowerFlex 753

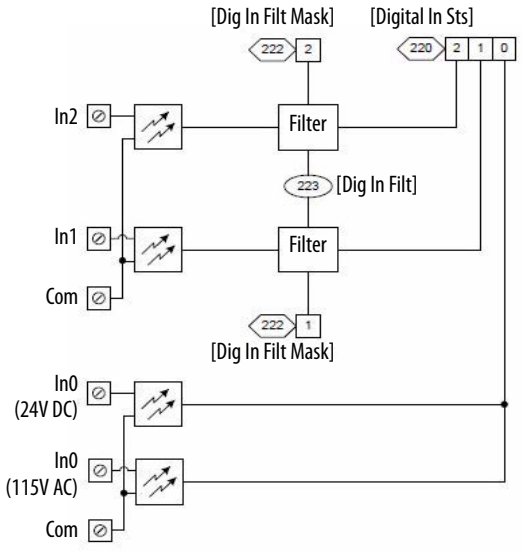


Figure 9 - PowerFlex 755

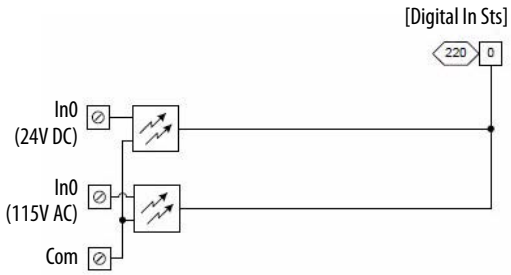
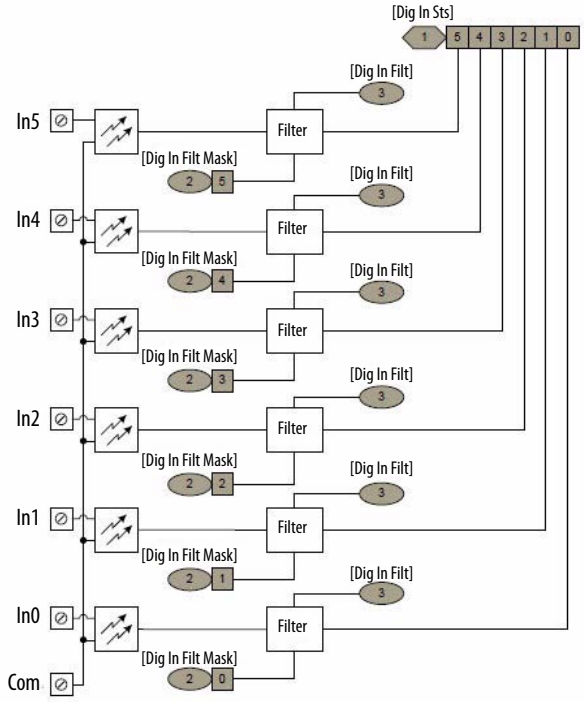


Figure 10 - PowerFlex 750-Series Option Module



Digital Outputs

The PowerFlex 753 has one transistor output and one relay output embedded on its main control board.

The transistor output is located on TB1 at the lower front of the main control board.

Terminal	Name	Description	Rating
T0	Transistor Output 0	Transistor Output	48V DC, 250 mA maximum load. Open drain output.

The relay output is located on TB2 at the bottom of the main control board.

Terminal	Name	Description	Rating
R0NC	Relay 0 N.C.	Output Relay 0 normally closed contact	240V AC, 24V DC, 2A max Resistive Only
R0C	Relay 0 Common	Output Relay 0 Common	
R0NO	Relay 0 N.O.	Output Relay 0 normally open contact	240V AC, 24V DC, 2A max General Purpose (Inductive) / Resistive

Refer to the PowerFlex 750-Series AC Drives Installation Instructions, publication 750-IN001, for PowerFlex 753 Main Control Board I/O wiring examples.

The PowerFlex 755 has no outputs embedded on its Main Control Board.

There are PowerFlex 750-Series Option Modules that expand the amount of digital outputs that can be used in both the PowerFlex 753 and 755 drives.

Catalog numbers 20-750-2262C-2R and 20-750-2262D-2R provide two relay outputs located on TB2 at the front of option module.

Terminal	Name	Description	Rating
R0NC	Relay 0 N.C.	Output Relay 0 normally closed contact	240V AC, 24V DC, 2A max Resistive Only
R0C	Relay 0 Common	Output Relay 0 common	
R0NO	Relay 0 N.O.	Output Relay 0 normally open contact	240V AC, 24V DC, 2A max General Purpose (Inductive) / Resistive
R1NC	Relay 1 N.C.	Output Relay 1 normally closed contact	240V AC, 24V DC, 2A max Resistive Only
R0C	Relay 1 Common Output	Relay 1 common	
R0NC	Relay 0 N.C.	Output Relay 0 normally closed contact	240V AC, 24V DC, 2A max Resistive Only

Catalog number 20-750-2263C-1R2T provides one transistor output and two relay outputs located on TB2 at the front of option module.

Terminal	Name	Description	Rating
R0NC	Relay 0 N.C.	Output Relay 0 normally closed contact	240V AC, 24V DC, 2A max Resistive Only
R0C	Relay 0 Common Output	Relay 0 common	
R0NO	Relay 0 N.O.	Output Relay 0 normally open contact	240V AC, 24V DC, 2A max General Purpose (Inductive) / Resistive
T0	Transistor Output 0	Transistor Output	24VDC = 1A max 24VDC = 0.4 Max for U.L. applications. Resistive
TC	Transistor Output Common	Transistor Output Common	
T1	Transistor Output 1	Transistor Output	24VDC = 1A max 24VDC = 0.4 Max for U.L. applications. Resistive

Refer to the PowerFlex 750-Series AC Drives Installation Instructions, publication 750-IN001, for PowerFlex 750-Series Option Module I/O wiring examples.

Configuration

Each digital output can be programmed to change state based on one of many different conditions. These conditions may fall into different categories as follows:

- Drive status conditions (fault, alarm, and reverse).
- Level conditions (DC bus voltage, current, and frequency)
- Controlled by a digital input.
- Controlled by the network.
- Controlled by DeviceLogix software.

Drive Status Conditions

For PowerFlex 750-Series drives utilizing an option module, the table below shows an overview of the selectable configurations for the drive's digital output Sel parameters.

Parameter No.	Parameter Name	Description
220(1)	Digital In Sts	Status of the digital inputs resident on the main control board (Port 0).
227(1)	R01 Sel or T00 Sel	Selects the source that will energize the relay or transistor output.
233(1)	R00 Level CmpSts	Status of the level compare, and a possible source for a relay or transistor output.
720	PTP PsnRefStatus	Displays the current operating status of the Point-To-Point Position Planner in the Position Referencing.
724	Psn Reg Status	Indicates status of position control logic.
730	Homing Status	Indicates status of position control logic.
933	Start Inhibits	Indicates which condition is preventing the drive from starting or running.
935	Drive Status 1	Present operating condition of the drive.

Parameter No.	Parameter Name	Description
936	Drive Status 2	Present operating condition of the drive.
937	Condition Sts 1	Status of conditions that may or may not result in the drive taking action (faulting), based on configuration of protective functions.
945	At Limit Status	Status of dynamic conditions within the drive that are either active or a limit is being applied.
952	Fault Status A	Indicates the occurrence of conditions that have been configured as faults. These conditions are from P937 [Condition Sts 1].
953	Fault Status B	Indicates the occurrence of conditions that have been configured as faults.
959	Alarm Status A	Indicates the occurrence of conditions that have been configured as alarms. These events are from P937 [Condition Sts 1].
960	Alarm Status B	Indicates the occurrence of conditions that have been configured as alarms.
961	Type 2 Alarms	Indicates the occurrence of conditions that have been configured as alarms.
1089	PID Status	Status of the Process PI regulator.
1103(2)	Trq Prove Status	Displays the status bits for TorqProve.
1210(2)	Profile Status	Indicates status of speed profile/position indexer control logic.
1(3)(4)	Digital In Sts	Status of the digital inputs.
7(3)(4)	Dig Out Setpoint	Controls Relay or Transistor Outputs when chosen as the source. Can be used to control outputs from a communication device using DataLinks.
13(3)(4)	R00 Level CmpSts	Status of the level compare, and a possible source for a relay or transistor output.
50(5)	DLX DigOut Sts	Provides the individual on/off status of the DLX Logic Command word bits.
51(5)	DLX DigOut Sts2	Provides the individual on/off status of the 16 DLX DOPs.

(1) PowerFlex 753 drives only.
(2) PowerFlex 755 drives only.
(3) Option modules can be used in Ports 4, 5, and 6 of PowerFlex 753 drives.
(4) Option modules can be used in Ports 4, 5, 6, 7, and 8 of PowerFlex 755 drives.
(5) Port 14: DeviceLogix software parameters.

Refer the PowerFlex 750-Series AC Drives Programming Manual for specific parameter bit level details.

Related PowerFlex 753 selection parameter information is noted below.

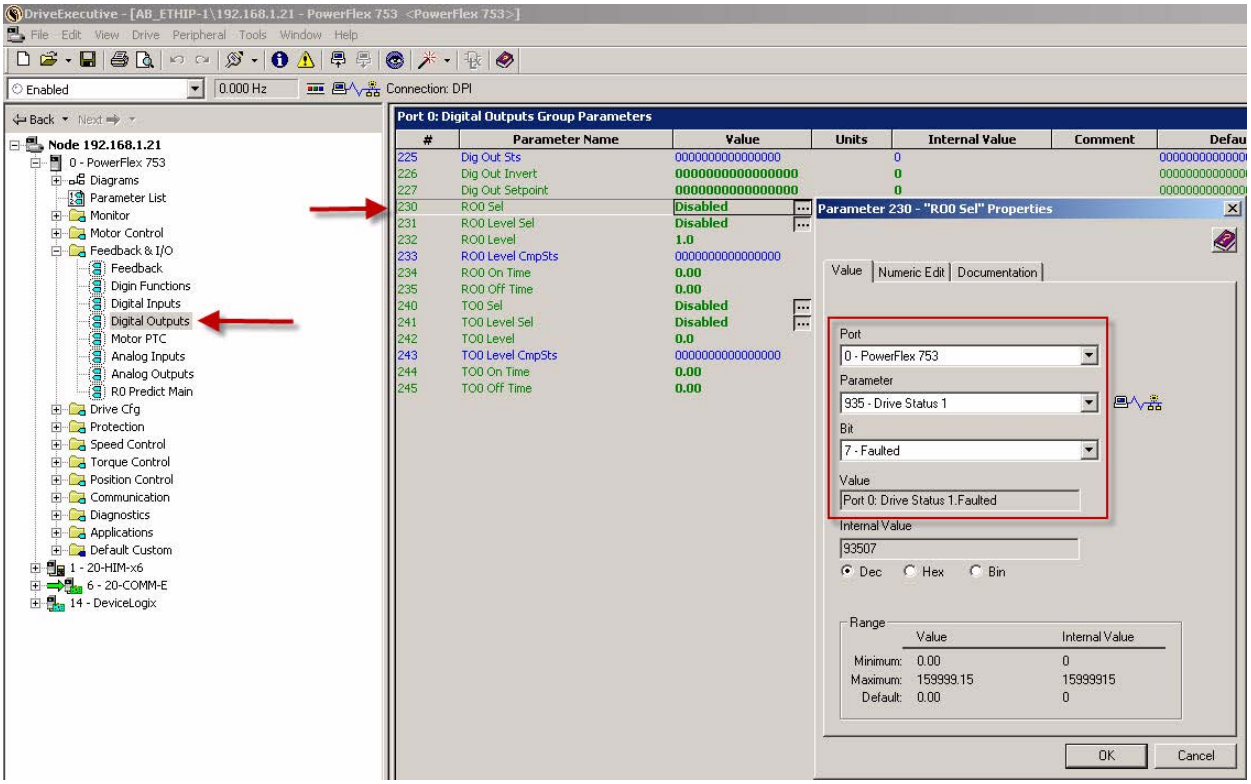
Parameter No.	Parameter Name	Description
230	R00 Sel	Selects the source that will energize the relay output.
240	T00 Sel	Selects the source that will energize the relay or transistor output.

Depending on the PowerFlex 750-Series Option Module or Modules installed in the drive, related selection parameter information is noted below.

Parameter No.	Parameter Name	Description
10	R00 Sel	Selects the source that will energize the relay output.
20	R01 Sel or T00 Sel	Selects the source that will energize the relay or transistor output.
30	T01 Sel	Selects the source that will energize the transistor output.

Example

Below is an example of a PowerFlex 753 drive's utilizing an embedded digital output Sel parameter being configured such that the output energizes when a fault is present on the drive.

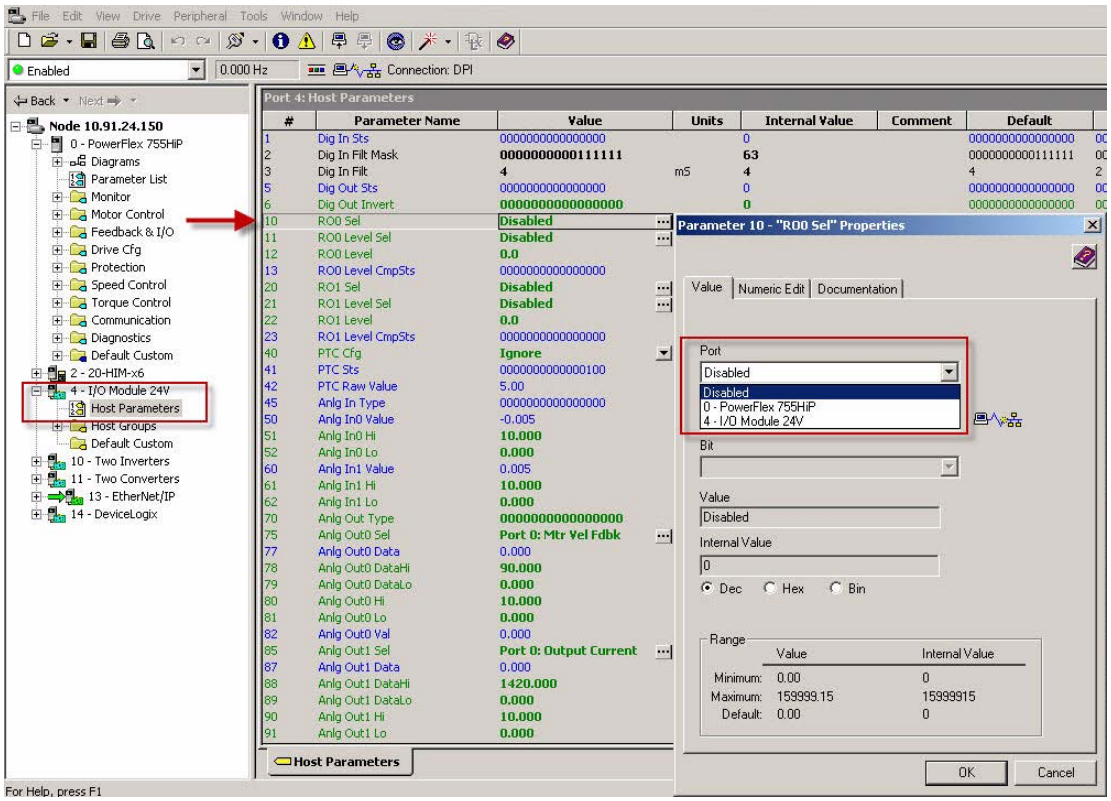


Example

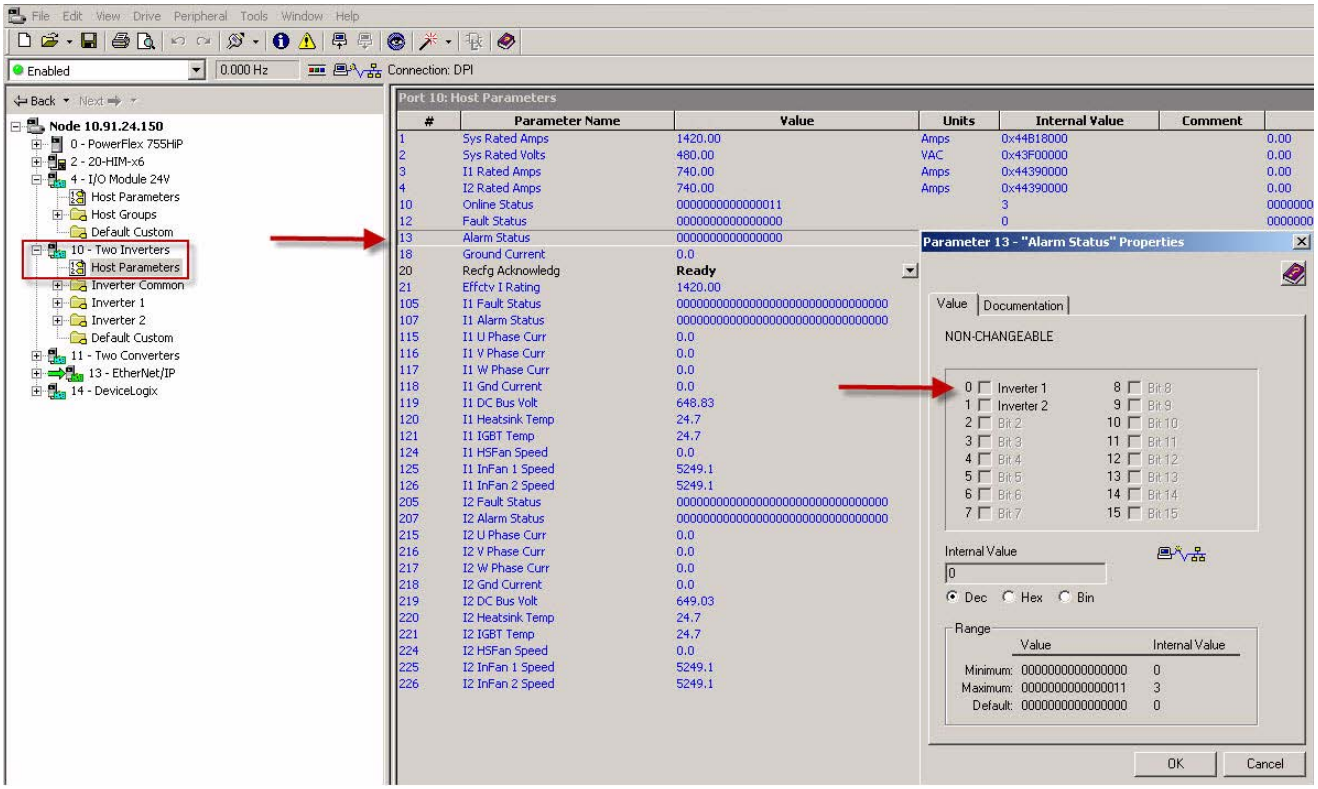
For parameters that are not configurable through the parameter properties' "Value" tab pull-down graphic user interface (GUI), you can utilize the "Numeric Edit" tab to alternatively configure the digital output for a desired function.

Below is an example of a PowerFlex 755 drive utilizing a PowerFlex 750-Series option module's digital output "Sel" parameter being configured such that the output energizes when an alarm is present on one of the drive's inverter section.

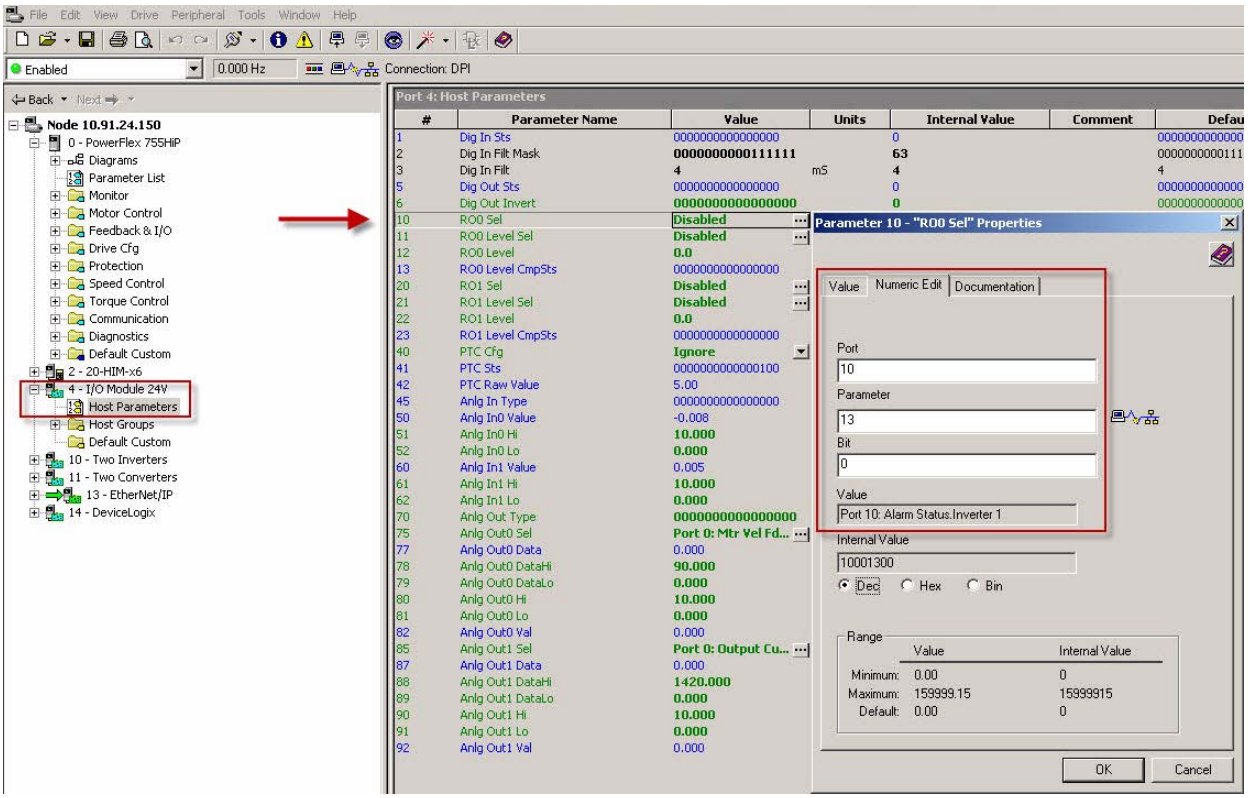
You can see below that you cannot select Port 10, Inverter section in the Value tab pull-down GUI.



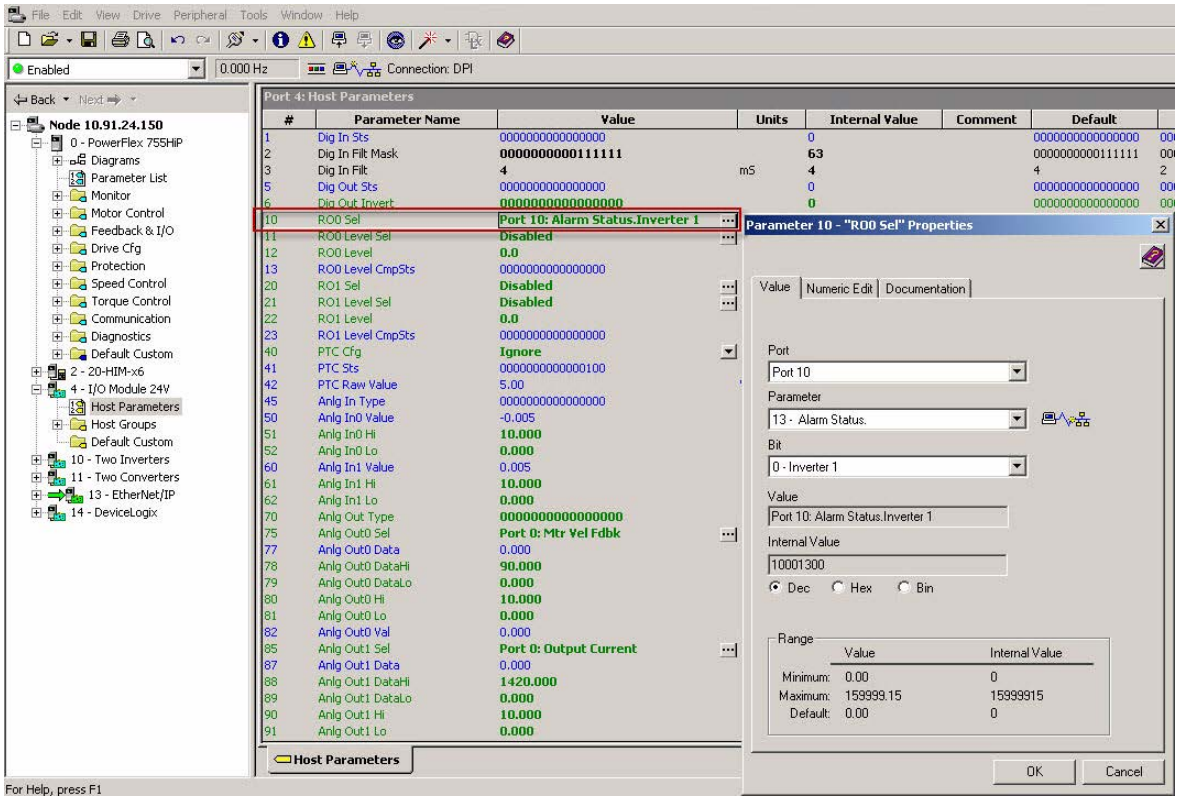
We look through the Port 10, Inverter section parameters and find that P13 [Alarm Status] Bit 0 shows if there is an active alarm on Inverter 1 section.


File Edit View Drive Peripheral Tools Window Help
Enabled
0.000 Hz
Connection: DPI
Back Next
Node 10.91.24.150
0 - PowerFlex 755HiP
2 - 20-HIM-x6
4 - I/O Module 24V
Host Parameters
Host Groups
Default Custom
10 - Two Inverters
Host Parameters
Inverter Common
Inverter 1
Inverter 2
Default Custom
11 - Two Converters
13 - EtherNet/IP
14 - DeviceLogix
Port 10: Host Parameters
Parameter Name Value Units Internal Value Comment
1 Sys Rated Amps 1420.00 Amps 0x44B18000 0.00
2 Sys Rated Volts 480.00 VAC 0x43F00000 0.00
3 I1 Rated Amps 740.00 Amps 0x44390000 0.00
4 I2 Rated Amps 740.00 Amps 0x44390000 0.00
10 Online Status 0000000000000011 3 0000000
12 Fault Status 0000000000000000 0 0000000
13 Alarm Status 0000000000000000
18 Ground Current 0.0
20 Recfg Acknowledg Ready
21 Effctv I Rating 1420.00
105 I1 Fault Status 00000000000000000000000000000000
107 I1 Alarm Status 00000000000000000000000000000000
115 I1 U Phase Curr 0.0
116 I1 V Phase Curr 0.0
117 I1 W Phase Curr 0.0
118 I1 Gnd Current 0.0
119 I1 DC Bus Volt 648.83
120 I1 Heatsink Temp 24.7
121 I1 IGBT Temp 24.7
124 I1 HSFan Speed 0.0
125 I1 InFan 1 Speed 5249.1
126 I1 InFan 2 Speed 5249.1
205 I2 Fault Status 00000000000000000000000000000000
207 I2 Alarm Status 00000000000000000000000000000000
215 I2 U Phase Curr 0.0
216 I2 V Phase Curr 0.0
217 I2 W Phase Curr 0.0
218 I2 Gnd Current 0.0
219 I2 DC Bus Volt 649.03
220 I2 Heatsink Temp 24.7
221 I2 IGBT Temp 24.7
224 I2 HSFan Speed 0.0
225 I2 InFan 1 Speed 5249.1
226 I2 InFan 2 Speed 5249.1
Parameter 13 - "Alarm Status" Properties
Value Documentation
NON-CHANGEABLE
0 Inverter 1
1 Inverter 2
2 Bit 2
3 Bit 3
4 Bit 4
5 Bit 5
6 Bit 6
7 Bit 7
8 Bit 8
9 Bit 9
10 Bit 10
11 Bit 11
12 Bit 12
13 Bit 13
14 Bit 14
15 Bit 15
Internal Value
0
Dec Hex Bin
Range
Value Internal Value
Minimum: 0000000000000000 0
Maximum: 0000000000000011 3
Default: 0000000000000000 0
OK
Cancel

Within the Numeric Edit tab we can configure the digital output for the desired function. See below.



Once the parameter is configured within the Numeric Edit tab, you can Click OK, or you can go back to the Value tab to see what populates in the pull-down GUI, then Click OK.



Level Conditions

A desired level function needs to be programmed into the “Level Sel” parameter, depending on the output being used. If the value for the specified function (frequency, current, and so forth) is greater than equal to or less than the programmed limit dictated by the “Level” parameter, the output will activate or deactivate depending on what the “Sel” parameter is configured for.

Notice that the Level Select parameters do not have units. The drive assumes the units and the minimum/maximum values from the selected parameter function. For example, if the “Level Sel” is programmed for P943 [Drive Temp Pct], which indicates operating temperature of the drive power section (heat-sink), its units are in percentage of the maximum heat-sink temperature with minimum/maximum values of -200/200 percent.

For the PowerFlex 750-Series drives utilizing an Option Module, the table below shows an overview of the selectable configurations for the drive's Digital Output "Level Sel" parameters.

Parameter No.	Parameter Name	Description
1	Output Frequency	Output frequency present at terminals T1, T2, and T3 (U, V & W).
2	Commanded SpdRef	Value of the active Speed/Frequency Reference.
3	Mtr Vel Fdbk	Estimated or actual motor speed, with feedback.
4	Commanded Trq	Final torque reference value after limits and filtering are applied. Percent of motor rated
5	Torque Cur Fdbk	Based on the motor, the amount of current that is in phase with the fundamental voltage component.
6	Flux Cur Fdbk	Amount of current that is out of phase with the fundamental voltage component.
7	Output Current	The total output current present at terminals T1, T2, and T3 (U, V & W).
8	Output Voltage	Output voltage present at terminals T1, T2, and T3 (U, V & W).
9	Output Power	Output power present at terminals T1, T2, and T3 (U, V & W).
10	Output Powr Fctr	Output power factor.
11	DC Bus Volts	DC bus voltage.
13	Elapsed MWH	Accumulated output energy of the drive.
14	Elapsed kWH	Accumulated output energy of the drive.
260(1)	Anlg In0 Value	Value of the Analog input after filter, square root, and loss action.
418	Mtr OL Counts	Accumulated percentage of motor overload.
419	Mtr OL Trip Time	Displays the inverse of the motor overload time.
558	MOP Reference	Value of the MOP (Motor Operated Potentiometer) Reference to be used as a possible source for P545 and P550.
707	Load Estimate	Displays an estimated load torque value for the drive.
940	Drive OL Count	Indicates power unit overload (IT) in percentage.
943	Drive Temp Pct	Indicates operating temperature of the drive power section (heat-sink) in percentage of the maximum heat-sink temperature.
1090	PID Ref Meter	Present value of the PI reference signal.
1091	PID Fdbk Meter	Present value of the PI feedback signal.
1092	PID Error Meter	Present value of the PI error.
1093	PID Output Meter	Present value of the PI output.
1567(2)	FrctnComp Out	Displays the torque reference output of the Friction Compensation function.
50(3)(4)	Anlg In0 Value	Value of the Analog input after filter, square root, and loss action.
60(3)(4)	Anlg In1 Value	Value of the Analog input after filter, square root, and loss action.
90 . . . 97(5)	DLX Real Out SP1 - SP8	Eight 32-bit Real scratchpad registers for DLX program output use.

(1) PowerFlex 753 drives only.
(2) PowerFlex 755 drives only.
(3) Option modules can be used in Ports 4, 5, and 6 of PowerFlex 753 drives.
(4) Option modules can be used in Ports 4, 5, 6, 7, and 8 of PowerFlex 755 drives.
(5) Port 14: DeviceLogix software parameters

Related PowerFlex 753 drives Level Select parameter information noted below.

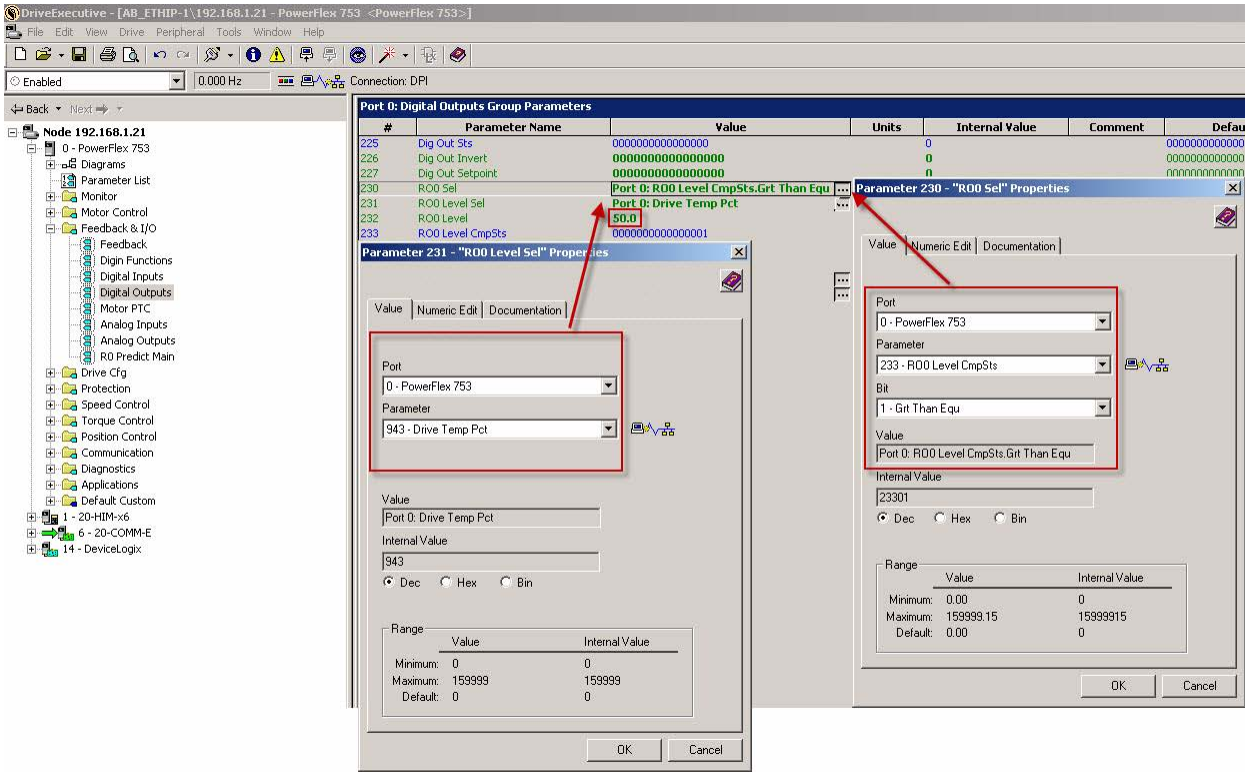
Parameter No.	Parameter Name	Description
230	R00 Sel	Selects the source that will energize the relay output.
231	R00 Level Sel	Selects the source of the level that will be compared.
232	R00 Level	Sets the level compare value.
233	R00 Level CmpSts	Status of the level compare, and a possible source for a relay or transistor output.
240	T00 Sel	Selects the source that will energize the relay or transistor output.
241	T00 Level Sel	Selects the source of the level that will be compared.
242	T00 Level	Sets the level compare value.
243	T00 Level CmpSts	Status of the level compare, and a possible source for the transistor output.

Depending on the PowerFlex 750-Series Option Module(s) installed in the drive, related Level Select parameter information noted below.

Parameter No.	Parameter Name	Description
10	R00 Sel	Selects the source that will energize the relay output.
11	R00 Level Sel	Selects the source of the level that will be compared.
12	R00 Level	Sets the level compare value.
13	R00 Level CmpSts	Status of the level compare, and a possible source for a relay or transistor output.
20	R01 Sel or T00 Sel	Selects the source that will energize the relay or transistor output.
21	R01 Level Sel or T00 Level Sel	Selects the source of the level that will be compared.
22	R01 Level or T00 Level	Sets the level compare value.
23	R01 Level CmpSts or T00 Level CmpSts	Status of the level compare, and a possible source for a relay or transistor output.
30	T01 Sel	Selects the source that will energize the transistor output.
31	T01 Level Sel	Selects the source of the level that will be compared.
32	T01 Level	Sets the level compare value.
10	R00 Sel	Selects the source that will energize the relay output.

Example

Below is an example of a PowerFlex 753 drive utilizing an embedded digital output Select, Level Select and Level parameters being configured such that the output energizes when the drive's operating temperature of the drive power section (heat-sink) in percentage of the maximum heat-sink temperature is greater than 50 percent.

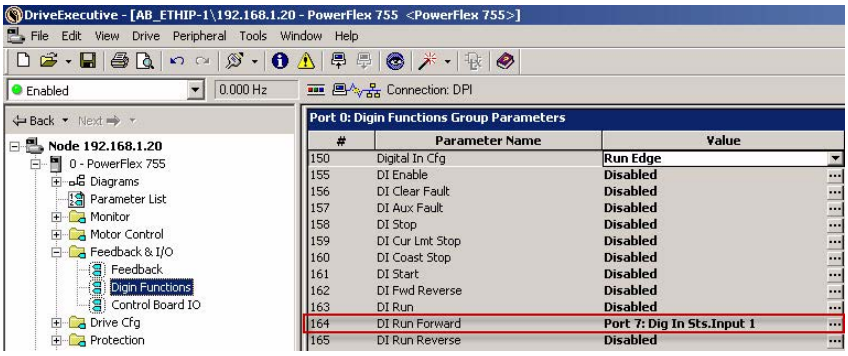


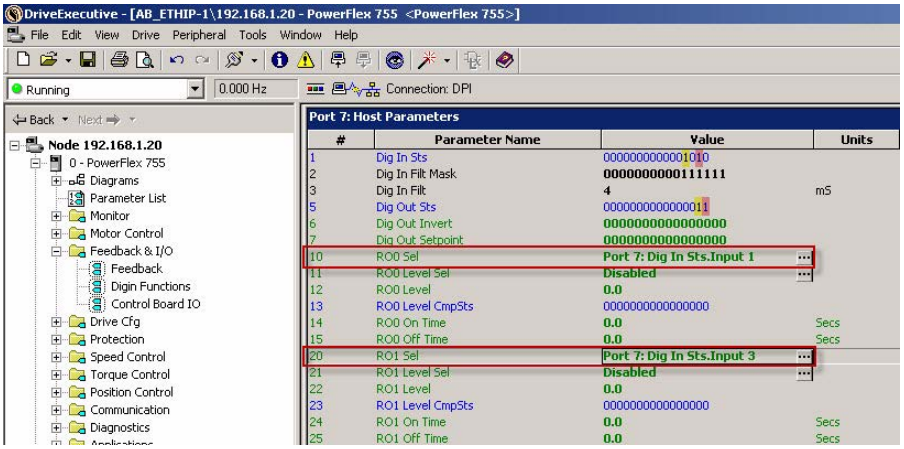
Controlled By Digital Input

A digital output can be programmed to be controlled by a digital input. For example, when the input is closed, the output will be energized, and when the input is open, the output will be de-energized. Note that the output will be controlled by the state of the input, even if the input has been assigned a normal drive function (Start, Jog, and so forth).

Example

In this example, the drive is utilizing a 24V DC, Two Relay Option Module in Port 7. One of the drive's digital input functions, P164 [DI Run Forward] is programmed for Port 7: Digital In Sts.Input 1, with Option Module P10 [RO0 Sel] is programmed for Port 7: Dig In Sts.Input 1 and P20 [RO1 Sel] is programmed for Port 7: Dig In Sts.Input 3.





As you can see with the picture above, when the Digital Inputs 1 (pink highlight) and 3 (yellow highlight) are true (on) their respective Digital Outputs are true (on) as well.

Controlled by Network

This configuration is used when it is desired to control the digital outputs over network communication instead of a drive related function. In the case for the PowerFlex 753 embedded digital outputs, P227 [Dig Out Setpoint] is utilized and in the case for the PowerFlex 750-Series Option Module, P7 [Dig Out Setpoint] is utilized. To complete the configuration for control over a network, a datalink must be configured for the respective Digital Output Setpoint parameter.

Related PowerFlex 753 Setpoint parameter information noted below.

File	Group	No.	Display Name Full Name Description	Values	Read-Write	Data Type
FEEDBACK & I/O	Digital Outputs	227	753 **Dig Out Setpoint** Digital Output Setpoint Controls Relay or Transistor Outputs when chosen as the source. Can be used to control outputs from a communication device using DataLinks.		RO	16-bit Integer

Options	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Trans Out 0	Relay Out 0
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

0 = Condition False
1 = Condition True

Depending on the PowerFlex 750-Series Option Module(s) installed in the drive, related Setpoint parameter information noted below.

File	Group	No.	Display Name Full Name Description	Values	Read-Write	Data Type
I/O	Digital Outputs	7	**Dig Out Setpoint** Digital Output Setpoint Controls Relay or Transistor Outputs when chosen as the source. Can be used to control outputs from a communication device using DataLinks.		RW	16-bit Integer

Options	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Trans Out 1 (2)	Trans Out 0 (1)	Relay Out 0
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

0 = Output De-energized
1 = Output Energized

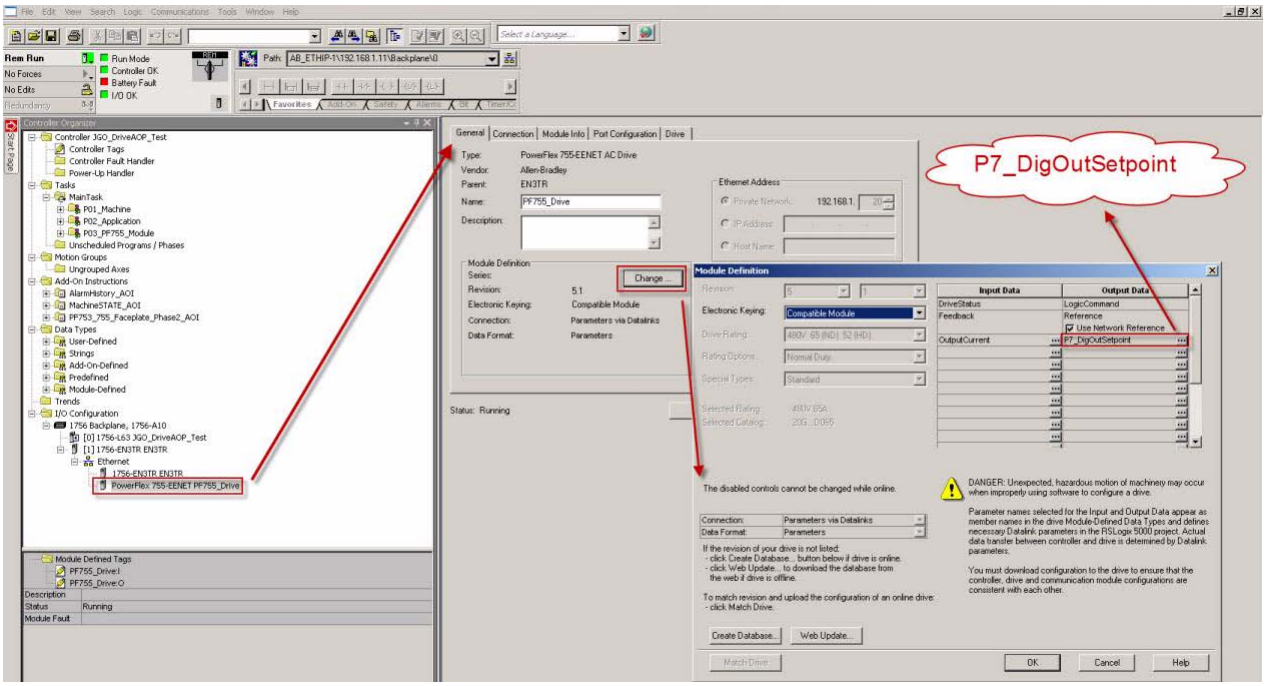
(1) Bit 1 = "Trans Out 0" for I/O Module model 20-750-2263C-1R2T
= "Relay Out 1" for I/O Module models 20-750-2262C-2R and 20-750-2262D-2R

(2) Bit 2 is only used by I/O Module 20-750-2263C-1R2T

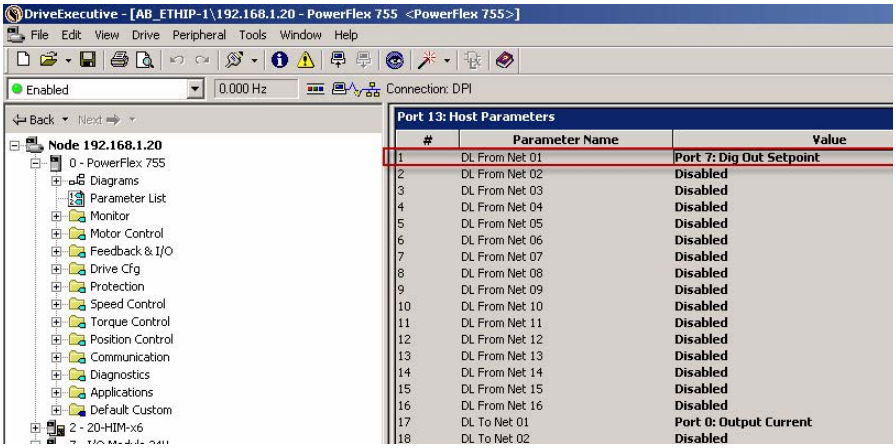
Example

For this example, our setup includes a PowerFlex 755 utilizing a 20-750-2262C-2R 24VDC I/O Option Module and a ControlLogix™ L63 processor. The drive's Option Module, P10 [RO0 Sel] is configured for Port 7: Dig Out Setpoint.Relay Out 0. We are utilizing the RSLogix 5000 programming software, which includes the Drives Add-On Profiles (AOPs). This gives us the ability to communicate and control the PowerFlex 755 drive over its embedded ethernet port via a datalink P7 [Dig Out Setpoint], Relay Out 0.

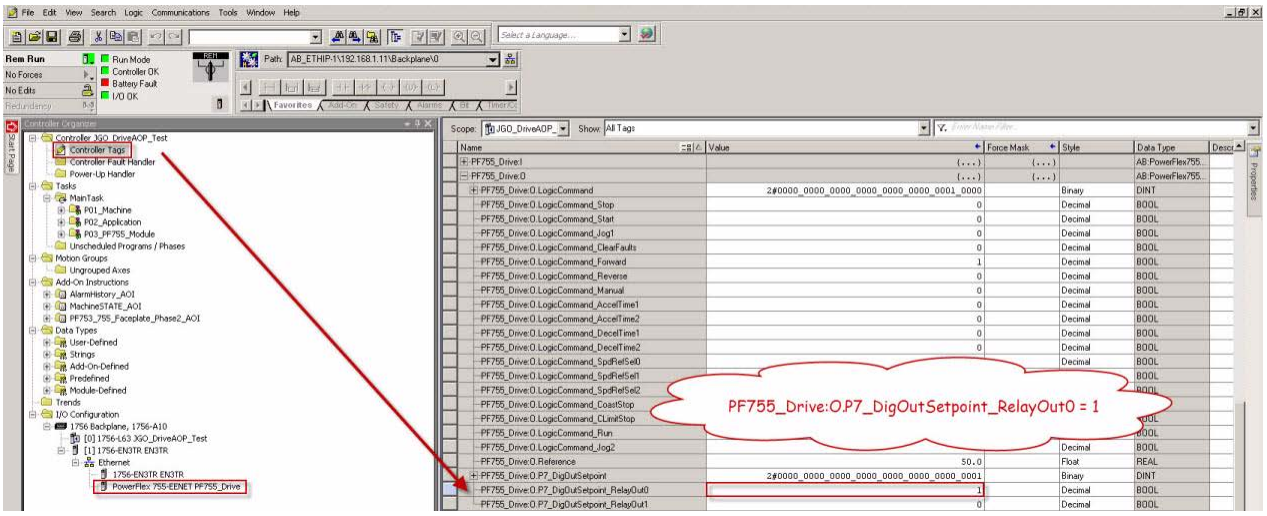
Below is a picture of the PowerFlex 755 drive Datalink configuration within RSLogix 5000.



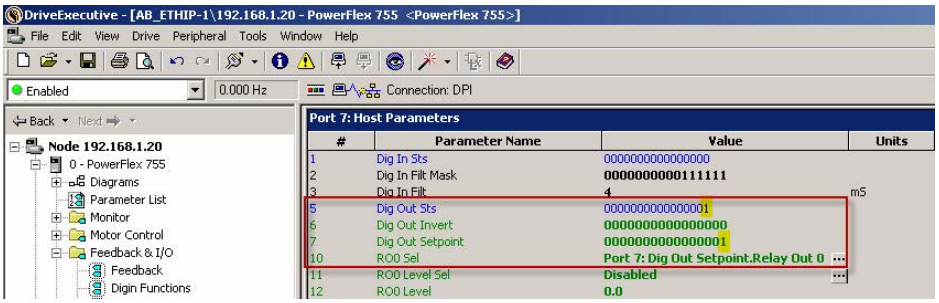
Below is a picture of the PowerFlex 755 drive Datalink configuration from DriveExecutive™.


DriveExecutive - [AB_ETHIP-1\192.168.1.20 - PowerFlex 755 <PowerFlex 755>]
File Edit View Drive Peripheral Tools Window Help
Enabled
0.000 Hz
Connection: DPI
Back Next
Node 192.168.1.20
0 - PowerFlex 755
Diagrams
Parameter List
Monitor
Motor Control
Feedback & I/O
Drive Cfg
Protection
Speed Control
Torque Control
Position Control
Communication
Diagnostics
Applications
Default Custom
2 - 20-HIM-x6
Port 13: Host Parameters
Parameter Name Value
1 DL From Net 01 Port 7: Dig Out Setpoint
2 DL From Net 02 Disabled
3 DL From Net 03 Disabled
4 DL From Net 04 Disabled
5 DL From Net 05 Disabled
6 DL From Net 06 Disabled
7 DL From Net 07 Disabled
8 DL From Net 08 Disabled
9 DL From Net 09 Disabled
10 DL From Net 10 Disabled
11 DL From Net 11 Disabled
12 DL From Net 12 Disabled
13 DL From Net 13 Disabled
14 DL From Net 14 Disabled
15 DL From Net 15 Disabled
16 DL From Net 16 Disabled
17 DL To Net 01 Port 0: Output Current
18 DL To Net 02 Disabled

Utilizing RSLogix 5000 Drive Add-On Profiles and a datalink, we can use the created descriptive controller tag (highlighted below) to communicate over a network to control the relay output.



The picture below shows the result of controlling the digital output over the network (yellow highlight).



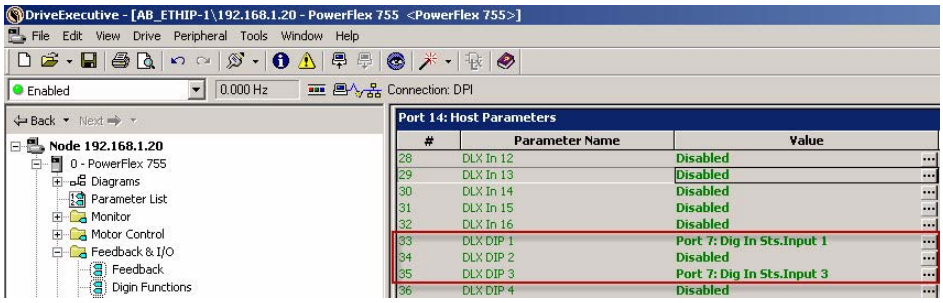
Controlled by DeviceLogix software

DeviceLogix software control technology provides you with the flexibility to customize a drive to more closely match your application needs. DeviceLogix software controls outputs and manages status information locally within the drive allowing you to operate the drive independently or complimentary to supervisory control helping to improve system performance and productivity. You can use the PowerFlex 750-Series DeviceLogix software to read inputs/write outputs and exclusively control the drive.

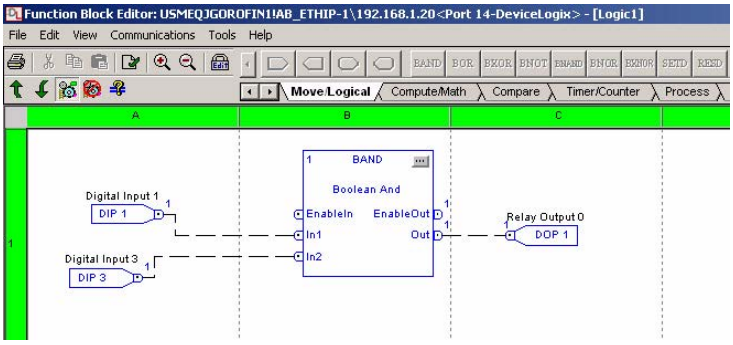
Example

In the example below, we are using two real world inputs, such as limit switches being wired into a PowerFlex 750-Series Option Module, and using a DeviceLogix software program to control a digital output.

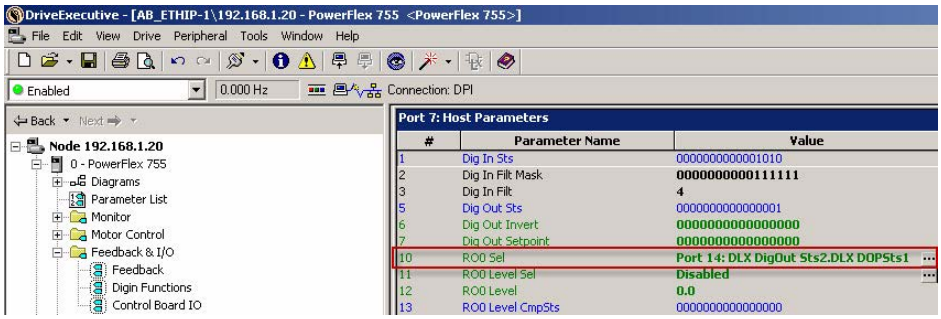
The picture below shows the DeviceLogix software Digital Input configuration. P33 [DLX DIP 1] is configured for Port 7: Dig In Sts.Input 1 and P35 [DLX DIP 3] is configured for Port 7: Dig In Sts.Input 3. This setup allows for us to bring in two real world inputs into DeviceLogix software.


DriveExecutive - [AB_ETHIP-1\192.168.1.20 - PowerFlex 755 <PowerFlex 755>]
File Edit View Drive Peripheral Tools Window Help
Enabled
0.000 Hz
Connection: DPI
Back Next
Node 192.168.1.20
0 - PowerFlex 755
Diagrams
Parameter List
Monitor
Motor Control
Feedback & I/O
Feedback
Digin Functions
Port 14: Host Parameters
Parameter Name Value
28 DLX In 12 Disabled
29 DLX In 13 Disabled
30 DLX In 14 Disabled
31 DLX In 15 Disabled
32 DLX In 16 Disabled
33 DLX DIP 1 Port 7: Dig In Sts.Input 1
34 DLX DIP 2 Disabled
35 DLX DIP 3 Port 7: Dig In Sts.Input 3
36 DLX DIP 4 Disabled

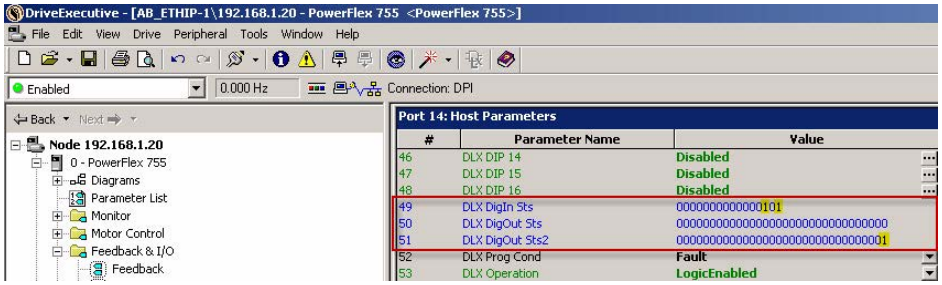
We then utilize a DeviceLogix software program so that when both Digital Input 1 and Digital Input 3 are true (on), the resultant is the DeviceLogix software Digital Output 1 (DOP 1) turns on.



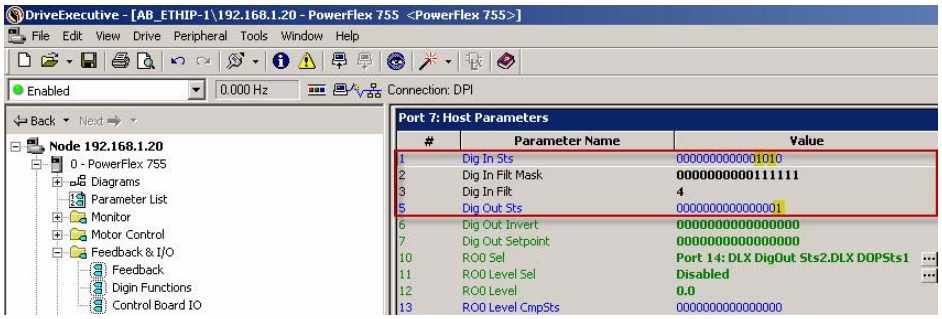
The picture below shows that the Option Module, P10 [RO0 Sel] is configured for DeviceLogix software Port 14: DLX DigOut Sts2.DLX DOPSts1. This links together the DeviceLogix software Digital Output 1 (DOP 1) to the drive's physical output, such that when the DOP 1 is high (on), the drive's Option Module relay output energizes.



The picture below shows the status of the DeviceLogix software inputs and outputs via P49 [DLX DigIn Sts] and P51 [DLX DigOut Sts2].



The picture below shows the status of the DeviceLogix software inputs and outputs via P1 [Dig In Sts] and P5 [Dig Out Sts].



Invert

There is a logical invert function associated with the PowerFlex 750-Series drive's digital outputs. For the PowerFlex 753, it is configured by P226 [Dig Out Invert], and for the PowerFlex 750-Series Option Module, it is configured by P6 [Dig Out Invert]. This invert function changes the output status bit from a zero, false state, to a one, true state, and vice versa.

This logical invert function requires power to be applied to the drive's control module for the drive's logic to be active. This can be obtained from powering up the drive's control module by either applying power to the drive's input section or from an external 24VDC being wired into the Auxiliary Power Supply Option Module.

PowerFlex 753 Invert parameter information noted below.

File	Group	No.	Display Name Full Name Description	Values	Read-Write	Data Type
FEEDBACK & I/O	Digital Outputs	226	**753 Dig Out Invert** Digital Output Invert Inverts the selected digital output.		RO	16-bit Integer

Options	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Trans Out 0	Relay Out 0
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

0 = Condition False
1 = Condition True

Depending on the PowerFlex 750-Series Option Module(s) installed, Invert parameter information noted below.

File	Group	No.	Display Name Full Name Description	Values	Read-Write	Data Type
I/O	Digital Outputs	6	**Dig Out Invert** Digital Output Invert Inverts the selected digital output.		RW	16-bit Integer

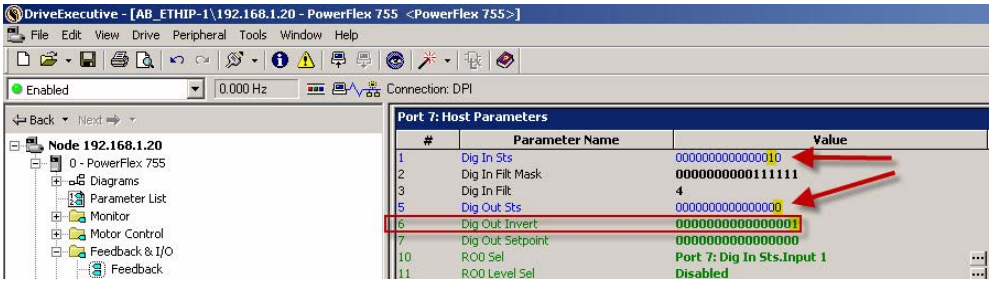
Options	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Trans Out 1 (2)	Trans Out 0 (1)	Relay Out 0
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

0 = Output Not Inverted
1 = Output Inverted

(1) Bit 1 = "Trans Out 0" for I/O Module model 20-750-2263C-1R2T.
= "Relay Out 1" for I/O Module models 20-750-2262C-2R and 20-750-2262D-2R.
(2) Bit 2 is used only by I/O Module 20-750-2263C-1R2T.

Example

In this example, the drive is utilizing a 24VDC, two relay Option Module in Port 7 with P10 [RO0 Sel] is programmed for Port 7: Dig In Sts.Input 1. Notice below when the Invert bit for Relay Out 0, when the input status is true (1), the digital output status bit is false (0).



On/Off Time

Each digital output has two user-controlled timers associated with it. The On timer defines the delay time between a False-to-True transition (condition appears) on the output condition and the corresponding change in state of the digital output. The Off timer defines the delay time between a True-to-False transition (condition disappears) on the output condition and the corresponding change in the state of the digital output. Either timer can be disabled by setting the corresponding delay time to zero.

PowerFlex 753 On/Off parameters noted below.

Parameter No.	Parameter Name	Description
234	R00 On Time	Sets the "ON Delay" time for the digital outputs. This is the time between the occurrence of a condition and activation of the relay.
235	R00 Off Time	Sets the "OFF Delay" time for the digital outputs. This is the time between the disappearance of a condition and de-activation of the relay.
244	T00 On Time	Sets the "ON Delay" time for the digital outputs. This is the time between the occurrence of a condition and activation of the relay or transistor.
245	T00 Off Time	Sets the "OFF Delay" time for the digital outputs. This is the time between the disappearance of a condition and de-activation of the relay or transistor.

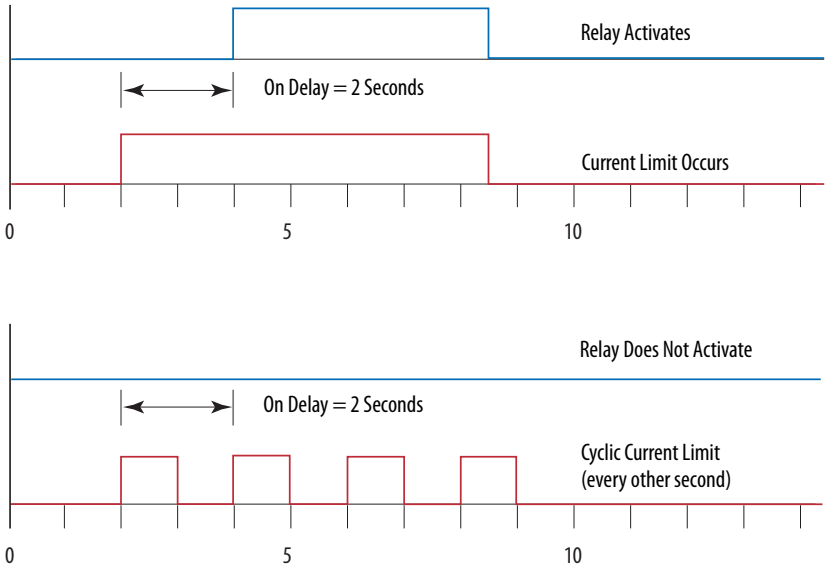
Depending on the PowerFlex 750-Series Option Module(s) installed, On/Off parameters noted below.

Parameter No.	Parameter Name	Description
14	R00 On Time	Sets the "ON Delay" time for the digital outputs. This is the time between the occurrence of a condition and activation of the relay.
15	R00 Off Time	Sets the "OFF Delay" time for the digital outputs. This is the time between the disappearance of a condition and de-activation of the relay.
24	R01 On Time or T00 On Time	Sets the "ON Delay" time for the digital outputs. This is the time between the occurrence of a condition and activation of the relay or transistor.
25	R01 Off Time or T00 Off Time	Sets the "OFF Delay" time for the digital outputs. This is the time between the disappearance of a condition and de-activation of the relay or transistor.
34	T01 On Time	Sets the "ON Delay" time for the digital outputs. This is the time between the occurrence of a condition and activation of the transistor.
35	T01 Off Time	Sets the "OFF Delay" time for the digital outputs. This is the time between the disappearance of a condition and de-activation of the transistor.

Whether a particular type of transition (False-to-True or True-to-False) on an output condition results in an energized or de-energized output depends on the output condition. If a transition on an output condition occurs and starts a timer, and the output condition goes back to its original state before the timer runs out, then the timer will be aborted and the corresponding digital output will not change state.

Example

For example, in the diagram below, a digital output is configured for P935 [Drive Status 1], Bit 27 "Cur Limit," the On Time is programmed for two seconds and the Off Time is programmed for 0 seconds.



Status

The [Dig Out Sts] parameter displays the status of the digital outputs and can be used for troubleshooting the digital outputs. When the bit in associated with the digital output is on, this means that the logic in the drive is telling that digital output to turn on. When the bit associated with the digital input is off, this means that the logic in the drive is telling that digital output to turn off.

PowerFlex 753 related Status parameter information noted below.

File	Group	No.	Display Name Full Name Description	Values	Read-Write	Data Type
FEEDBACK & I/O	Digital Outputs	225	753 **Dig Out Sts** Digital Output Status Status of the digital outputs.		RO	16-bit Integer

Options	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Trans Out 0	Relay Out 0
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

0 = Condition False
1 = Condition True

File	Group	No.	Display Name Full Name Description	Values	Read-Write	Data Type
I/O	Digital Outputs	5	**Dig Out Sts** Digital Output Status Status of the digital outputs.		RO	16-bit Integer

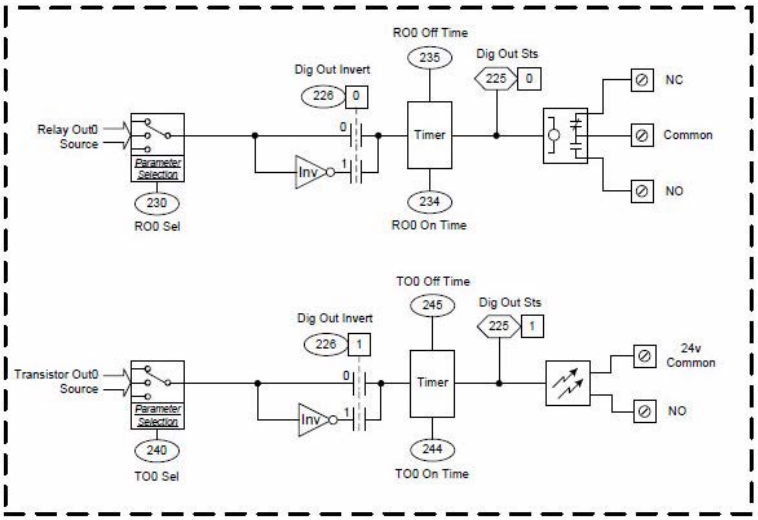
Options	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Trans Out 1(2)	Trans Out 0(1)	Relay Out 0
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

0 = Output De-energized
1 = Output Energized

(1) Bit 1 = "Trans Out 0" for I/O Module model 20-750-2263C-1R2T.
= "Relay Out 1" for I/O Module models 20-750-2262C-2R and 20-750-2262D-2R.
(2) Bit 2 is used only by I/O Module 20-750-2263C-1R2T.

Block Diagrams

Figure 11 - PowerFlex 753 Drive



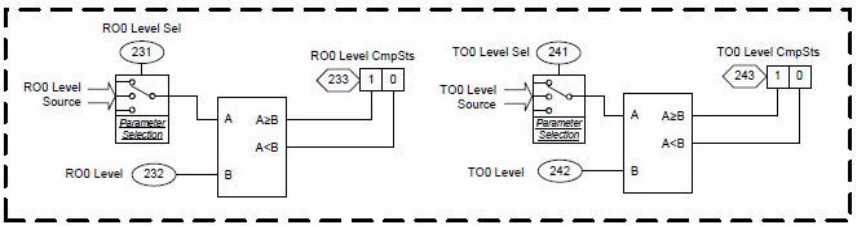
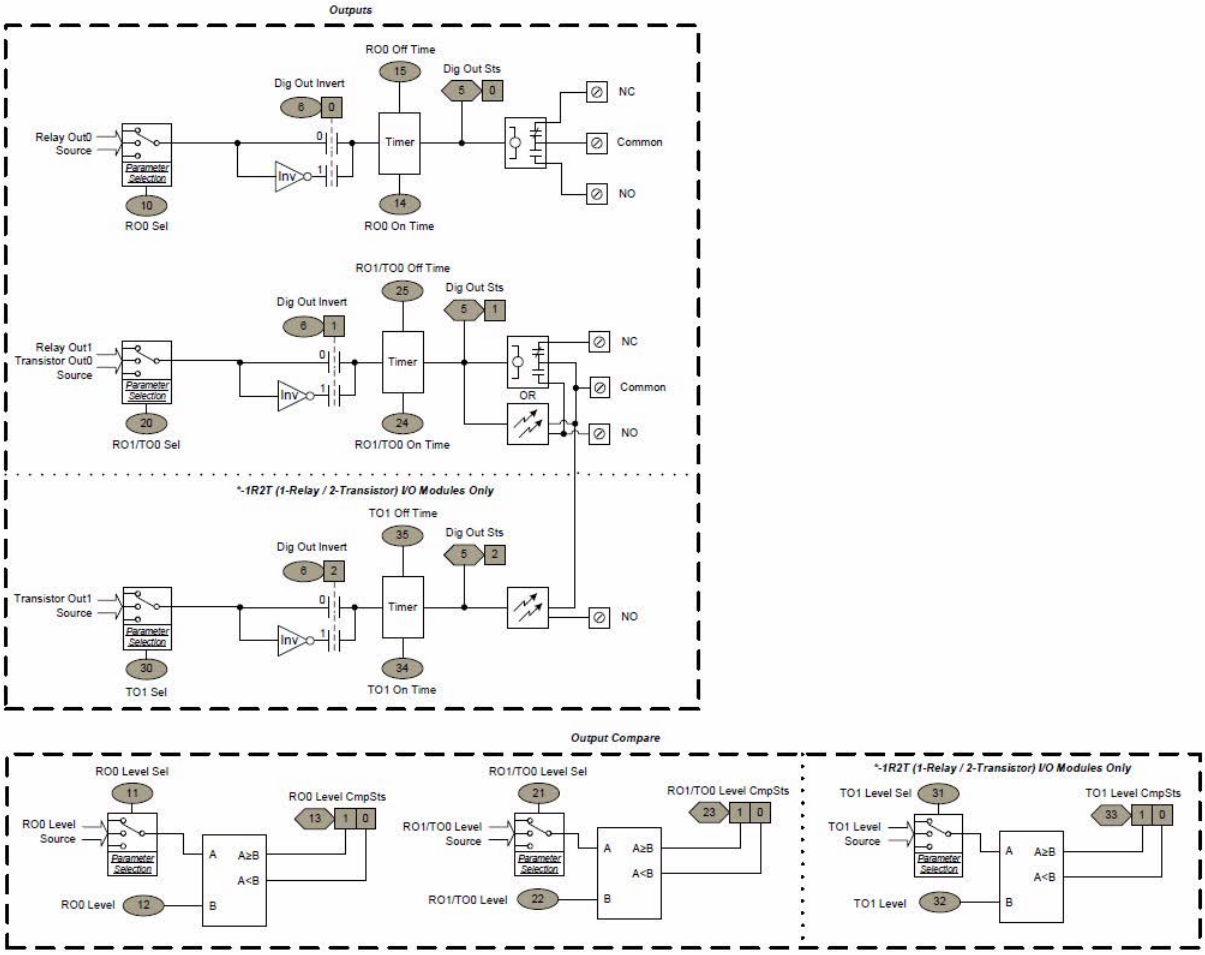


Figure 12 - PowerFlex 750-Series Option Module



Notes:

Diagnostics and Protection

DC Bus Voltage/Memory

P11 [DC Bus Volts] is a measurement of the instantaneous value. P12 [DC Bus Memory] is a heavily filtered value or average bus voltage. Just after the pre-charge relay is closed during initial powerup, bus memory is set equal to bus voltage. Thereafter it is updated to the 6 minute average of the instantaneous DC Bus Voltage.

Bus memory is used as a comparison value to sense a power loss condition. If the drive enters a power loss state, the bus memory will also be used for recovery (for example pre-charge control or inertia ride through) upon return of the power source. Update of the bus memory is blocked during deceleration to prevent a false high value caused by a regenerative condition.

Input Phase Loss Detection

Occasionally, three-phase power sources can fail on one phase while continuing to deliver power between the remaining 2 phases (single-phase). Operating above 50% output under this single-phase condition can damage the drive. If such a condition is likely, we recommend that Input Phase Loss Detection be enabled. The drive can be programmed to turn on an alarm bit or issue a drive fault (minor or major). The drive accomplishes this by interpreting voltage ripple on the DC bus.

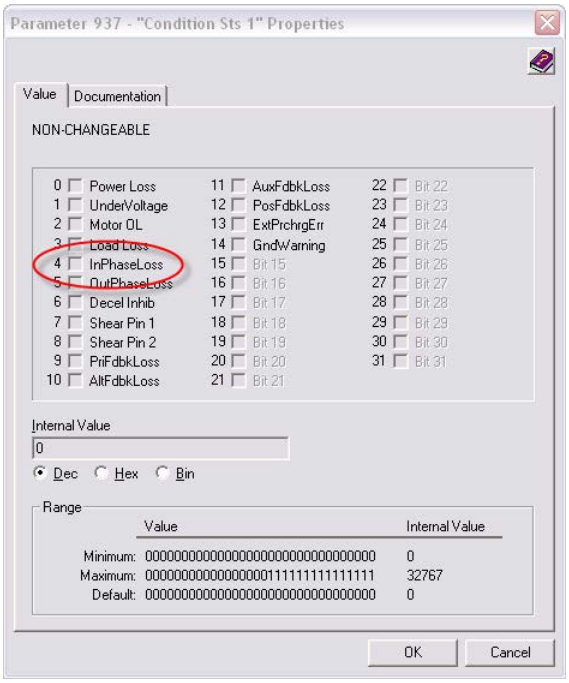
Configuring Input Phase Loss Action

P462 [InPhase LossActn]

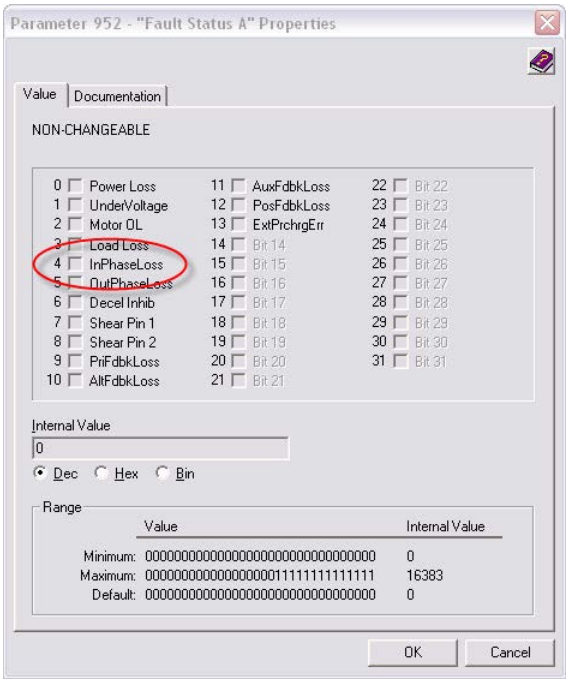
The following bits configure Input Phase Loss action:

- "Ignore" (0) – No action is taken. This may seriously degrade the drive.
- "Alarm" (1) – Type 1 alarm indicated.
- "Flt Minor" (2) – Minor fault indicated. If running, drive continues to run. Enable with P950 [Minor Flt Cfg]. If not enabled, acts like a major fault.
- "FltCoastStop" (3) – Major fault indicated. Coast to Stop.
- "Flt RampStop" (4) – Major fault indicated. Ramp to Stop.
- "Flt CL Stop" (5) – Major fault indicated. Current Limit Stop.

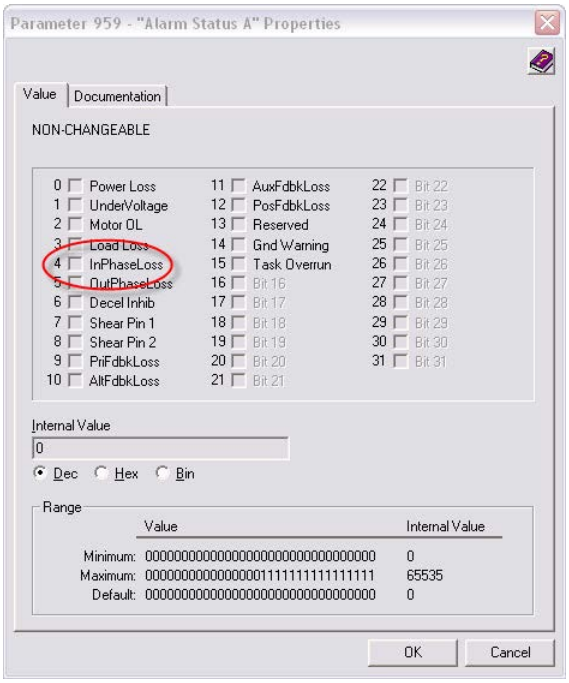
An input phase loss will be indicated in P937 [Condition Sts 1] Bit 4 “InPhaseLoss.”



If a fault action has been selected as a result of an input phase loss, P952 [Fault Status A] Bit 4 “InPhaseLoss” will be set.



If an alarm action is selected as a result for the input phase loss, P959 [Alarm Status A] Bit 4 “InPhaseLoss” will be set.



P463 [InPhase Loss Lvl]

Sets the threshold at which the DC bus voltage ripple triggers an F17 “Input Phase Loss” fault. Input phase loss is assumed when the DC bus voltage ripple exceeds the tolerance set by this parameter for a certain time period of time. Setting a larger value permits a higher bus voltage ripple without causing the drive to fault but also would allow more heating in the bus capacitors shortening the life or possible failure. The default value of 325 is equal to the expected ripple level for a full rated motor running at half load with single phase input. This is just a different way of saying that if you know you are going to run single phase, the drive should be derated by 50%.

Loading conditions on the motor could also have an effect on this parameter. Particularly shock loads.

Overspeed Limit

An overspeed condition results when the motor speed falls outside of its normal operating range. The forward motor rotation limit is P520 [Max Fwd Speed] + P524 [Overspeed Limit] and the reverse motor rotation limit is P521 [Max Rev Speed] - P524 [Overspeed Limit]. In Flux Vector Control mode or Scalar Control mode with encoder, the motor speed used is a 2msec averaged value of P131 [Active Vel Fdbk]. In Scalar Control mode without an encoder, the overspeed check uses P1 [Output Frequency]. The overspeed condition must exist for at least 16 milliseconds before it causes a fault to occur.

CIP Motion

When a PowerFlex 755 drive is running as a CIP Motion drive, then attribute 695 “Motor Overspeed User Limit” will specify the overspeed trip point directly. This attribute has units of percent of motor rated speed. So, if attribute 695 is set to 120% then the overspeed fault will occur at or above 120% rated speed.

Interior Permanent Magnet

For Interior Permanent Magnet motor control mode, an additional limit is placed on the Speed Limit + Overspeed threshold. This threshold is not allowed to exceed the setting in P1641 [IPM Max Spd] and is a +/- check. P1641 [IPM Max Spd] is set to the speed at which the motor will produce the voltage limit of the drive. If the drive faults while the motor is rotating at this speed, the motor will produce a voltage at the output of the drive. This voltage could damage the drive if the limit is exceeded. This limit is calculated while performing the rotate portion of the Autotune tests. For example, if P1641 calculated to be 57.82 Hz, then the overspeed limit threshold will be set by the Speed Limit + Overspeed Limit parameters and the results will be limited to a value of +/- 57.82 Hz.

Real Time Clock

The PowerFlex 755 is equipped with a real-time clock with a battery backup. This allows for programming of real time in the drive, and keeping that time even if the drives power is removed. This allows actual timestamps instead of runtime timestamps for faults and events. It is also used in the runtime accumulation of maintenance items such as total run time, number of times fans are running and so forth. If a battery is installed and the time values are set, time will be accumulated. Approximate battery life is 4.5 years with drive unpowered, or lifetime if drive is powered.

The real time clock on the drive may be set two different ways. It can either be set from the HIM, or from Drive Executive/Drive Explorer.

Setting the Real Time Clock via Drive HIM

1. Access the Status screen.
2. If Port 00 (Host Drive) is not shown above the ESC soft key, use the or key to scroll to Port 00.
3. Press the key to display its last-viewed folder.
4. Use the or key to scroll to PROPERTIES folder.
5. Use the or key to select Set Date and Time.
6. Press the (Enter) key to display its last-viewed folder.
7. Press the EDIT soft key to access the Set Date and Time mode screen, which highlights the present time zone line.
8. To select the time zone (set the drive to the current time zone).
   - Press the ZONES soft key to display the Select Time Zone screen.
   - Use the or key to select your basic time zone region (for example, Full List).
   - Press the (Enter) key to enter your selection.
   - Use the or key to select your specific time zone (for example, Chicago), and press the (Enter) key to enter it.
9. To set the date (set the drive to the current date).
   - Press the ▲ soft key to select the year in the top line, and use the numeric keys to enter the correct year.

To delete an erroneous date (or time) entry, use the ← soft key. Also, a partial or complete date (or time) value will not update until you press the ► soft key to enter the data. You will have to press the ? soft key a second time to advance to another field or press the ESC soft key to return to the previous screen.

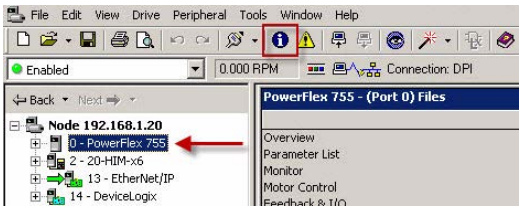
- Press the ► soft key to select the month in the top line, and use the numeric keys to enter the correct month.
- Press the ► soft key to select the day in the top line, and use the numeric keys to enter the correct day.

10. To set the time (set the drive to the current time).
    - Press the ► soft key to select the hour in the top line, and use the numeric keys to enter the correct hour.
    - Press the ► soft key to select the minutes in the top line, and use the numeric keys to enter the correct minute.
    - Press the ► soft key to select the seconds in the top line, and use the numeric keys to enter the correct seconds.
11. Press the ESC soft key to return to the previous screen.

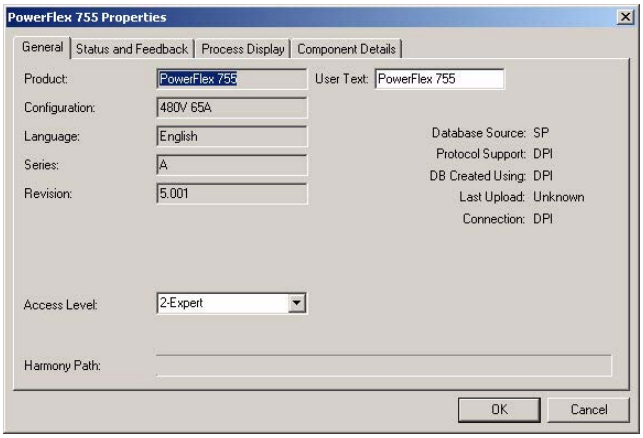
Setting the Real Time Clock via Drive Software

To set the real time clock using a software package like DriveExecutive or DriveExplorer™ software the procedure is the same.

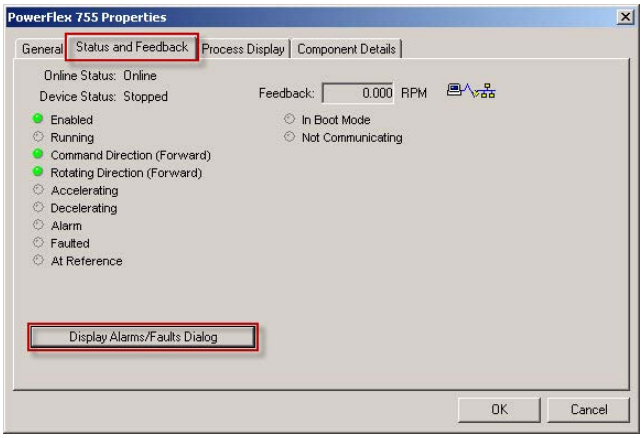
1. First press the located at the top center of the application.



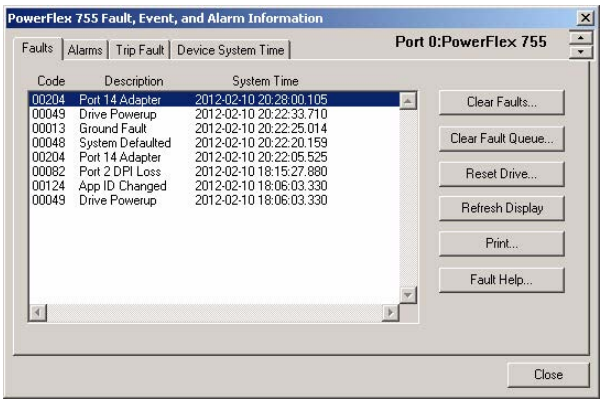
This dialog box appears.



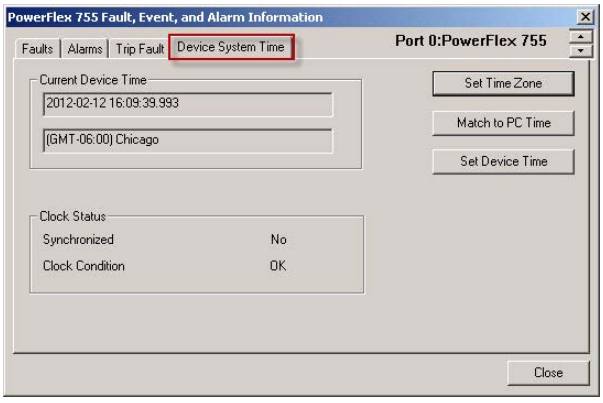
2. Click the Status and Feedback tab.
3. Click Display Alarms/Faults Dialog.



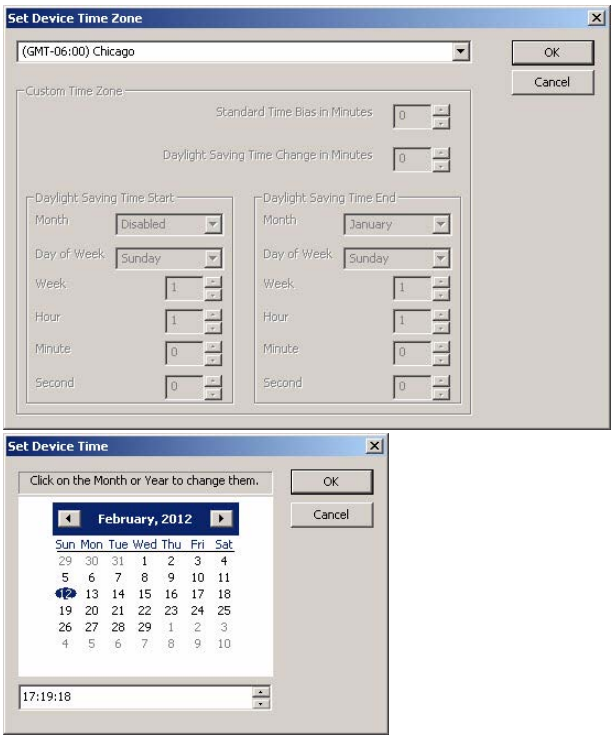
A new dialog box appears.



4. Click the Device System Time tab.



5. If necessary, change the values in the Set Time Zone and Set Device Time dialog boxes.



Installing Battery

To install the battery, first locate the main control board. The location of the main control board is in the far right location of the control POD. The main control board for the PowerFlex 753 and 755 drives are shown below.

Figure 13 - PowerFlex 753 Main Control Board

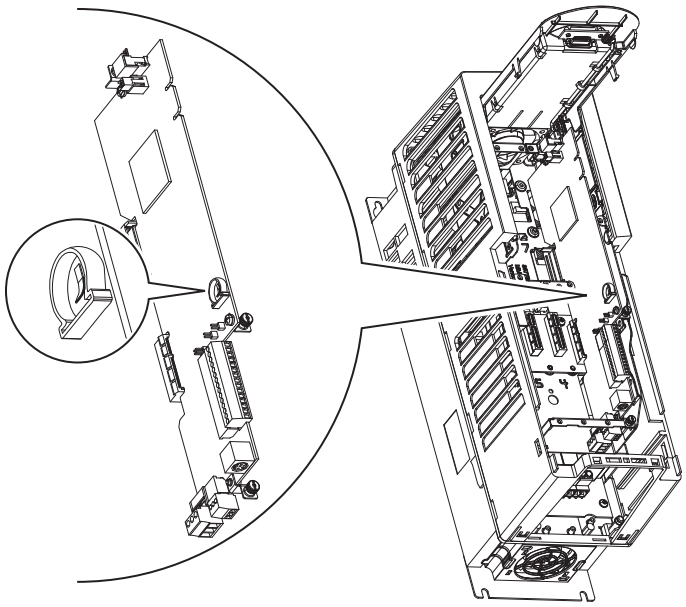
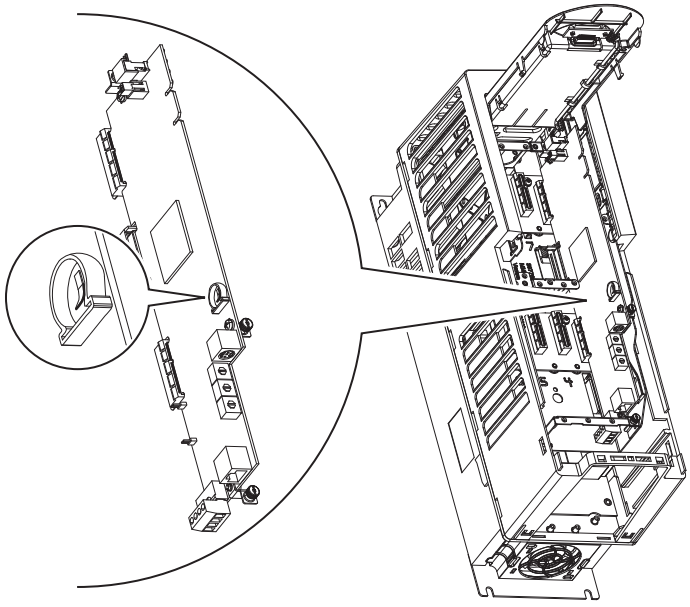


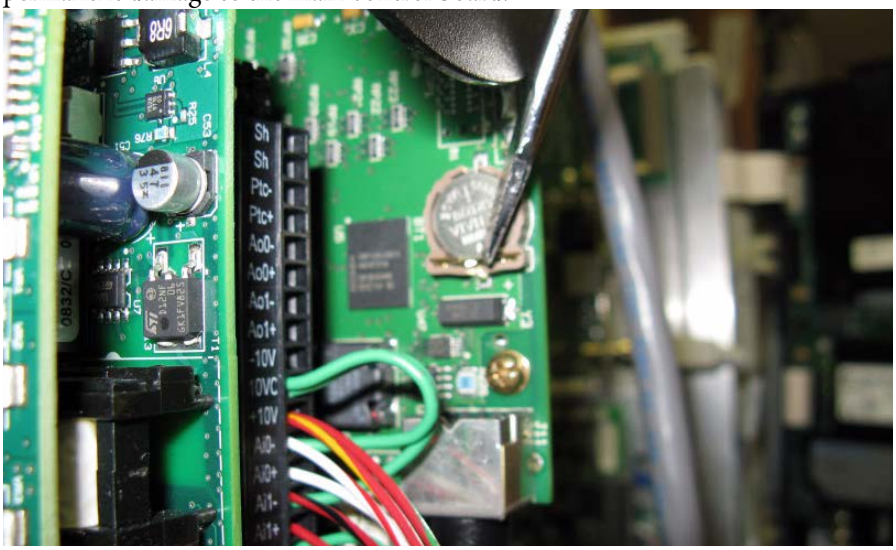
Figure 14 - PowerFlex 755 Main Control Board



The battery is installed in pointer position 3. The battery receptacle requires a user-installed CR1220 lithium coin cell battery that provides power to the Real Time Clock. Installing a battery preserves the Real Time Clock setting in the event power to the drive is lost or cycled. Approximate battery life is 4.5 years with drive unpowered, or lifetime if drive is powered. The battery should be installed with "+" facing out.

Removing Battery

To remove the battery, simply use a screwdriver to press down on the metal tab going across the battery. Prying the battery out of its holder may result in permanent damage to the main control board.



Slip Regulator

The slip regulator is used to compensate for temperature changes in an induction motor when FOC is used. The slip regulator uses a model of the motor to determine the desired d-axis voltage for a given operating point. A PI regulator is then used to change the drive's slip gain controlling the d-axis motor voltage. This in turn compensates for motor temperature (resistance) changes. The operation of the slip regulator is limited to regions where there is sufficient voltage (feedback or estimate) for the regulator to converge.

As default the slip regulator is enabled.

This regulator should never be disabled. If you feel you need to disable this function, you should consult the factory for verification.

Motor Control

Dynamic Braking

When an induction motor's rotor is turning slower than the synchronous speed set by the drive's output power; the motor is transforming electrical energy obtained from the drive into mechanical energy available at the drive shaft of the motor. This process is referred to as motoring.

When the rotor is turning faster than the synchronous speed set by the drive's output power, the motor is transforming mechanical energy available at the drive shaft of the motor into electrical energy that can be transferred back into the utility grid. This process is referred to as regeneration.

On most AC PWM drives, the AC power available from the fixed frequency utility grid is first converted into DC power by means of a diode rectifier bridge or controlled SCR bridge, before being inverted into variable frequency AC power. These diode or SCR bridges are very cost effective, but can handle power in only one direction, and that direction is the motoring direction. If the motor is regenerating, the bridge is unable to conduct the necessary negative DC current, and the DC bus voltage will increase until the drive trips off due to a Bus Overvoltage trip.

There are bridge configurations, using either SCRs or Transistors that have the ability to transform DC regenerative electrical energy into fixed frequency utility electrical energy but are expensive. A much more cost effective solution is to provide a Transistor Chopper on the DC bus of the AC PWM drive that feeds a power resistor, which transforms the regenerative electrical energy into thermal heat energy, which is dissipated into the local environment.

This process is generally called Dynamic Braking, with the Chopper Transistor and related control and components called the Chopper Module, and the power resistor called the Dynamic Brake Resistor. The entire assembly of Chopper Module with Dynamic Brake Resistor is sometime referred to as the Dynamic Brake Module.

Chopper Modules are designed to be applied in parallel if the current rating is insufficient for the application. One Chopper Module is the designated Master Chopper Module, while any other Modules are the designated Follower Modules. Two lights have been provided on the front of the enclosure to indicate Chopper Module operation – the DC Power light and the Brake On light. The DC Power light will be lit when DC power has been applied to the Chopper Module. The Brake On light will be lit when the Chopper Module is operating or chopping and will be a flickering type of indication.

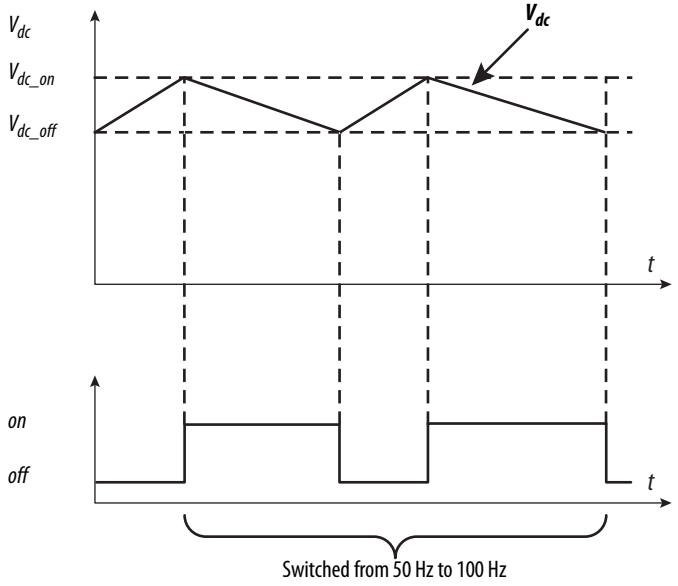
Update: As of December of 2010, Rockwell Automation no longer has a Chopper Module product as well as a Dynamic Braking Module product. The light configuration stated above was specific to the Rockwell Automation product.

How it Works

There are two different types of control for dynamic braking, hysteretic control and PWM control. Each used by themselves in a standard stand alone product has no advantage over the other. The preferred control would be the PWM method when the application is common DC bus. This advantage is described below.

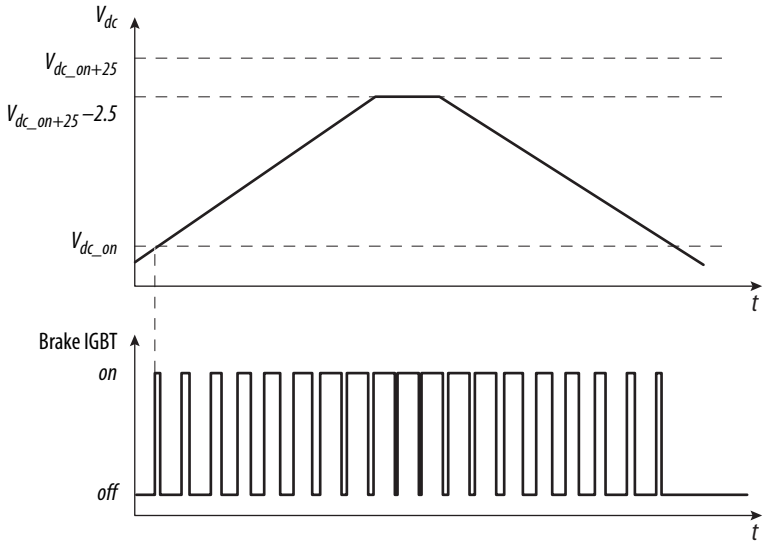
Hysteretic Control

The hysteretic method of dynamic braking uses a voltage sensing circuit to monitor the DC bus. As the DC bus voltage increases to the V_{dc_on} level the brake IGBT is turned on and is left on until the voltage drops to the V_{dc_off} level, which is not so desirable in common DC bus applications—see below. Some PowerFlex drives allow the V_{dc_off} level, [DB Threshold], to be adjusted if the application required it. Setting this level lower will make the dynamic braking more responsive but could lead to excessive DB activation.

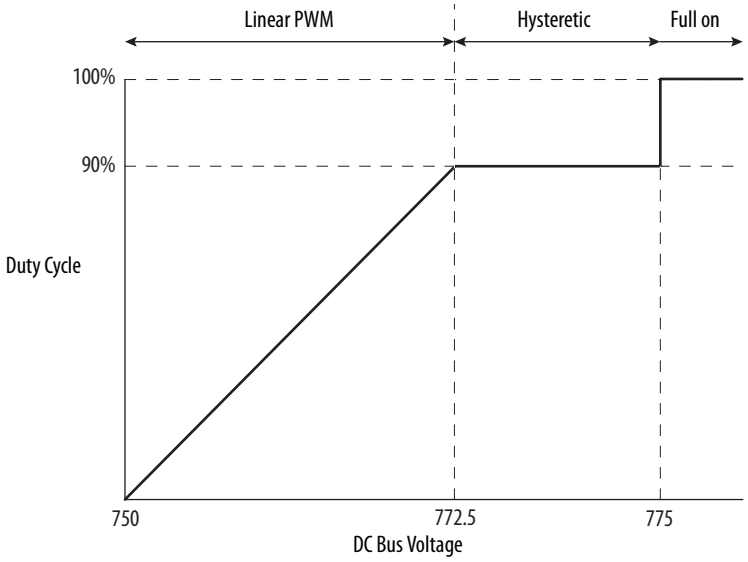


PWM Control

This type of control to operate the brake IGBT is similar to the way output voltage to the motor is controlled. As the DC bus voltage increases and hits some predetermined limit the brake IGBT is turned on/off according to a control algorithm switched at 1 kHz. This type of control virtually eliminates bus ripple. The big advantage is when this type of control is in a common bus configuration.

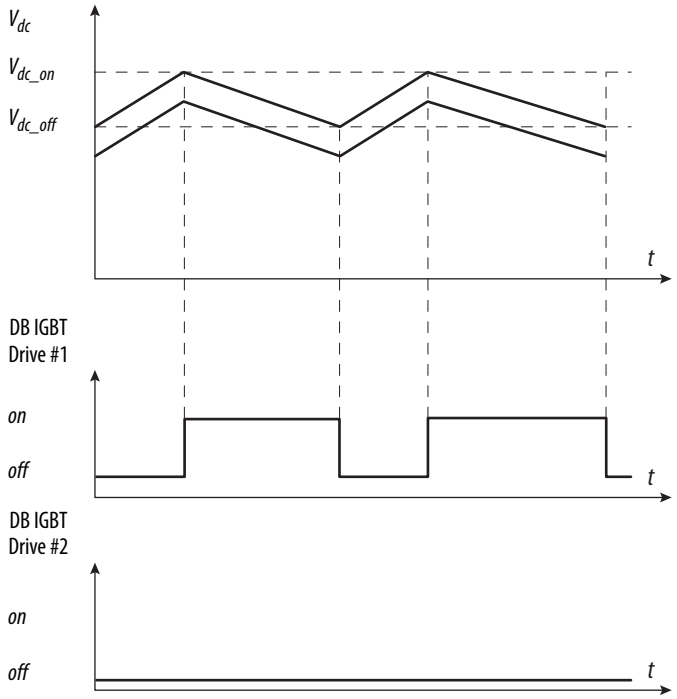


Duty Cycle

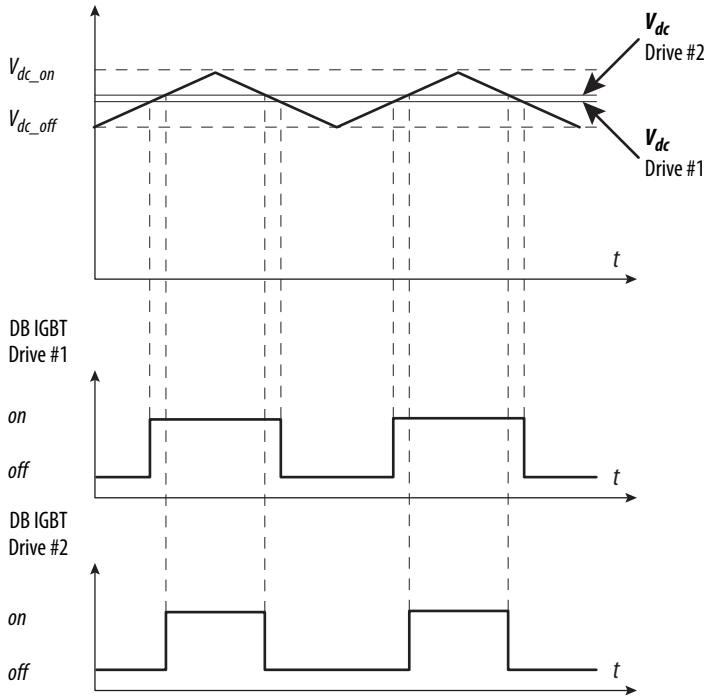


Common DC Bus Applications

In a common bus configuration when a dynamic braking resistor is installed on each drive sharing the DC bus, it's possible that the brake IGBT in some drives may not turn on, giving the impression that the drive is not functioning correctly or seeing one drive's brake IGBT failing consistently while the other drives are fine. Looking at the below diagram, it shows the DC bus level for two drives on common bus. The delta between these voltages are exaggerated for clarity. As the voltage increases, the Drive #1 IGBT turns on and decreases the voltage level before Drive #2 sees voltage high enough to be told to turn on. This results in Drive #1 doing all the dynamic braking. Now this situation could be alright as long as the minimum ohmic value for resistance is not violated and the regen event isn't so great that a single resistor can't handle the power. Of course, if there is a large regen event where the voltage continues to rise after Drive #1 has turned on, Drive #2 will fire its IGBT when it reaches the voltage limit.



Here are two drives with PWM DB control on a common bus. Since one drive will turn on at a certain duty cycle the bus voltage will likely continue to rise guaranteeing that the other drive's IGBT will turn on (at a different duty cycle).



How to Select A Chopper Module and Dynamic Brake Resistor

In general, the motor power rating, speed, torque, and details regarding the Regenerative mode of operation will be needed to estimate what Chopper Module rating and Dynamic Brake Resistor value to use. A rule of thumb to use is that a Dynamic Brake Module can be specified when regenerative energy is dissipated on an occasional or periodic basis. When a drive is consistently operating in the Regenerative mode of operation, serious consideration should be given to equipment that will transform the electrical energy back to the fixed frequency utility.

The peak regenerative power of the drive must be calculated to determine the maximum Ohmic value of the Dynamic Brake Resistor and to estimate the minimum current rating of the Chopper Module. The Rating of the Chopper Module is chosen from the Brake Chopper Module manual. Once the Chopper Module current rating is known, a minimum Dynamic Brake Resistance value is also known. A range of allowable Dynamic Brake Ohmic values is now known. These values exist from the minimum value set by the Chopper Transistor current rating to a maximum value set by the peak regenerative power developed by the drive to decelerate or satisfy other regenerative applications. If a Dynamic Brake Resistance value less than the minimum imposed by the choice of the Chopper Module is made and applied, damage can occur to the Chopper Transistor. If a Dynamic Brake Resistance value greater than the maximum

imposed by the choice of the peak regenerative drive power is made and applied, the drive can trip off due to transient DC bus overvoltage problems. Once the choice of the approximate Ohmic value of the Dynamic Brake Resistor is made, the wattage rating of the Dynamic Brake Resistor can be made.

The wattage rating of the Dynamic Brake Resistor is estimated by applying the knowledge of the drive motoring and regenerating modes of operation. The average power dissipation of the Regenerative mode must be estimated and the wattage of the Dynamic Brake Resistor chosen to be slightly greater than the average power dissipation of the drive. If the Dynamic Brake Resistor has a large thermodynamic heat capacity, then the resistor element will be able to absorb a large amount of energy without the temperature of the resistor element exceeding the operational temperature rating. Thermal time constants in the order of 50 seconds and higher satisfy the criteria of large heat capacities for these applications. If a resistor has a small heat capacity, the temperature of the resistor element could exceed the maximum temperature limits during the application of pulse power to the element and could exceed the safe temperature limits of the resistor.

The peak regenerative power can be calculated in English units (Horsepower), in The International System of Units (SI) (Watts), or in the per unit system (pu), which is dimensionless for the most part. In any event, the final number must in Watts of power to estimate Dynamic Brake Ohmic value. Calculations in this page will be demonstrated in SI units.

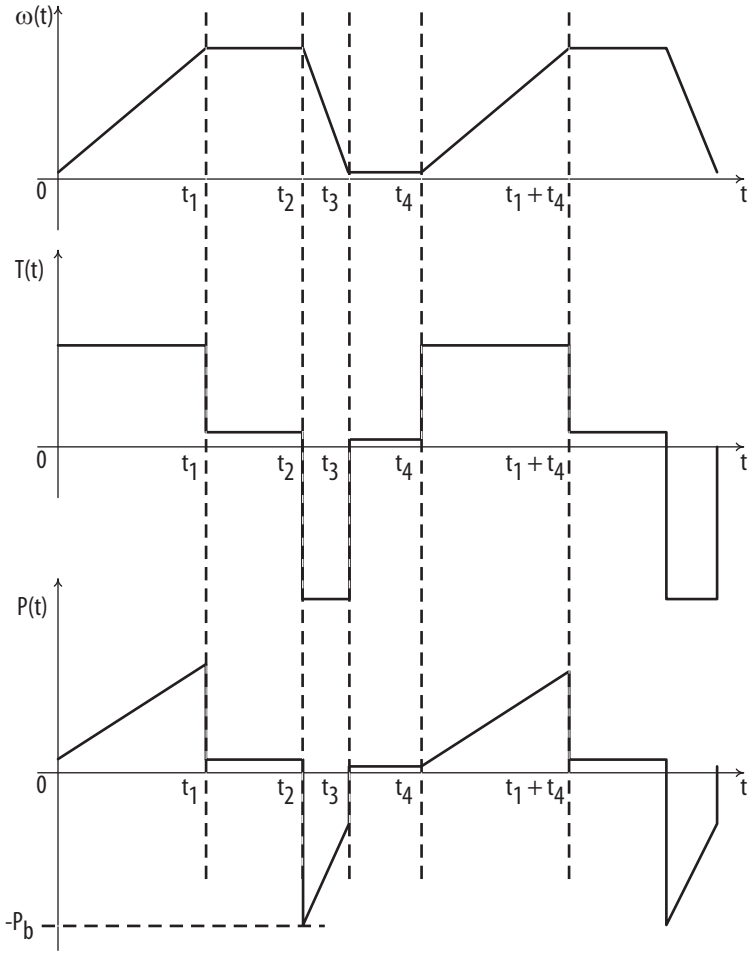
Speed, Torque, Power Profile

The following figure is a typical dynamic braking application. The top trace represents speed and is designated by the omega symbol. In the profile the motor is accelerated to some speed, it holds that speed for a period of time and is then decelerated. This deceleration is not necessarily to zero speed. The cycle is then repeated.

The middle trace represents motor torque. Torque starts out high as the motor is accelerated then drops down to maintain the commanded speed. Then the torque turns negative as the motor is decelerated. The cycle is then repeated.

The bottom trace represents motor power. Power increases as the motor speed increases. Power decreases some to maintain the commanded speed then goes

negative when deceleration starts. (this point called -Pb is the first value that needs to be calculated). The cycle is then repeated.



Dynamic Braking Module (no longer a Rockwell Automation product)

Figure 15 - shows a simplified schematic of a Chopper Module with Dynamic Brake Resistor. The Chopper Module is shown connected to the positive and negative DC bus conductors of an AC PWM Drive. The two series connected Bus Caps are part of the DC bus filter of the AC Drive. The significant power components of the Chopper Module are the protective fusing, the Crowbar SCR, the Chopper Transistor (an IGBT), the Chopper Transistor Voltage Control (hysteretic voltage comparator), and a freewheel diode for the Dynamic Brake Resistor.

The protective fuse is sized to work in conjunction with the Crowbar SCR. Sensing circuitry within the Chopper Transistor Voltage Control determines if abnormal conditions exist within the Chopper Module. One of these abnormal conditions is a shorted Chopper Transistor. If this condition is sensed, the Chopper Transistor Voltage Control will fire the Crowbar SCR, shorting the DC

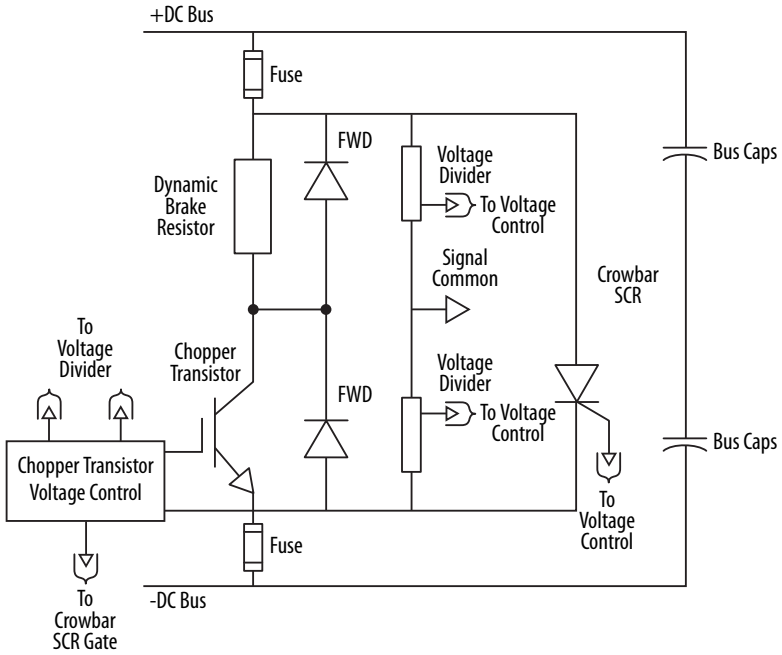
bus, and melting the fuse links. This action isolates the Chopper Module from the DC bus until the problem can be resolved.

The Chopper Transistor is an Isolated Gate Bipolar Transistor (IGBT). There are several transistor ratings that are used in the various Chopper Module ratings. The most important rating is the collector current rating of the Chopper Transistor that helps to determine the minimum Ohmic value used for the Dynamic Brake Resistor. The Chopper Transistor is either ON or OFF, connecting the Dynamic Brake Resistor to the DC bus and dissipating power, or isolating the resistor from the DC bus.

The Chopper Transistor Voltage Control regulates the voltage of the DC bus during regeneration. The average value of DC bus voltage is 375V DC (for 230V AC input), 750V DC (for 460V AC input), and 937.5V DC (for 575V AC input). The voltage dividers reduce the DC bus voltage to a low enough value that is usable in signal circuit isolation and control. The DC bus feedback voltage from the voltage dividers is compared to a reference voltage to actuate the Chopper Transistor.

The Freewheel Diode (FWD) in parallel with the Dynamic Brake Resistor allows any magnetic energy stored in the parasitic inductance of that circuit to be safely dissipated during turn off of the Chopper Transistor.

Figure 15 - Chopper Module Schematic



Sizing the Dynamic Brake Module Gather the following information.

1. The nameplate power rating of the motor in watts, kilowatts, or horsepower.
2. The nameplate speed rating of the motor in rpm or rps.

3. The motor inertia and load inertia in kilogram-meters2, or lb•ft^2.
4. The gear ratio, if a gear is present between the motor and load, GR.
5. Review the Speed, Torque Power profile of the application.

Equations used for calculating Dynamic Braking values will use the following variables.

$\omega(t)$ = The motor shaft speed in Radians/second, or $\omega Rad/s = \frac{2\pi N}{60} RPM$

$N_{(t)}$ = The motor shaft speed in Revolutions Per Minute, or RPM

$T_{(t)}$ = The motor shaft torque in Newton-meters, 1.01 lb•ft - 1.355818N•m

$P_{(t)}$ = The motor shaft power in Watts, 1.0HP = 746 Watts

$-P_b$ = The motor shaft peak regenerative power in Watts

Step 1 – Determine the Total Inertia

$J_T = J_m + GR^2 \times J_L$

J_T = Total inertia reflected to the motor shaft, kilogram-meters^2, kg•m^2, or pound-feet^2, lb•ft^2

J_m = Motor inertia, kilogram-meters2, kg•m^2, or pound-feet2, lb•ft^2

GR = The gear ratio for any gear between motor and load, dimentionless

J_L = Load inertia, kilogram-meters2, kg•m^2, or pound-feet2, lb•ft^2 – 1 lb•ft^2 = 0.04214011 kg•m^2

Step 2 – Calculate the Peak Braking Power

$$P_b = \frac{J_T \times \omega^2}{t_3 - t_2}$$

J_T = Total inertia reflected to the motor shaft, kg•m^2

ω = rated angular rotational speed, $Rad/s = \frac{2\pi N}{60}$

N = Rated motor speed, RPM

$t_3 - t_2$ = total time of deceleration from rated speed to 0 speed, in seconds

P_b = peak braking power, watts (1.0 HP = 746 Watts)

Compare the peak braking power to that of the rated motor power, if the peak braking power is greater that 1.5 times that of the motor, the deceleration time, ($t_3 - t_2$), needs to be increased so that the drive does not go into current limit. Use 1.5 times because the drive can handle 150% current maximum for 3 seconds.

Peak power can be reduced by the losses of the motor and inverter.

Step 3 – Calculating the Maximum Dynamic Brake Resistance Value

$$R_{db1} = \frac{V_d^2}{P_b}$$

V_d = The value of DC bus voltage that the chopper module regulates at and will equal 375V DC, 750V DC, or 937.5V DC

P_b = The peak braking power calculated in Step 2

R_{db1} = The maximum allowable value for the dynamic brake resistor

The choice of the Dynamic Brake resistance value should be less than the value calculated in Step 3. If the value is greater than the calculated value, the drive can trip on DC bus overvoltage. Remember to account for resistor tolerances.

Step 4 – Choosing the correct Dynamic Brake Module

Cat. No.	Resistance	Wattage
240 Volt		
KA005	28 ohms	666 watts
KA010	13.2 ohms	1650 watts
KA050	N/A	N/A
460 Volt		
KB005	108 ohms	1500 watts
KB010	52.7 ohms	2063 watts
KB050	10.5 ohms	7000 watts
600 Volt		
KC005	108 ohms	1500 watts
KC010	52.7 ohms	2063 watts
KC050	15.8 ohms	8000 watts

In the table above, choose the correct Dynamic Brake Module based upon the resistance value being less than the maximum value of resistance calculated in Step 3. If the Dynamic Brake Resistor value of one Dynamic Brake Module is not sufficiently low, consider using up to three Dynamic Brake Modules in parallel, such that the parallel Dynamic Brake resistance is less than Rdb1 calculated in

Step 3. If the parallel combination of Dynamic Brake Modules becomes too complicated for the application, consider using a Brake Chopper Module with a separately specified Dynamic Brake Resistor.

Step 5 – Estimate average power

It is assumed that the application exhibits a periodic function of acceleration and deceleration. If $(t_3 - t_2)$ = the time in seconds necessary for deceleration from rated speed to 0 speed, and t_4 is the time in seconds before the process repeats itself, then the average duty cycle is $(t_3 - t_2)/t_4$. The power as a function of time is a linearly decreasing function from a value equal to the peak regenerative power to 0 after $(t_3 - t_2)$ seconds have elapsed. The average power regenerated over the interval of $(t_3 - t_2)$ seconds is Pb/2. The average power in watts regenerated over the period t_4 is:

$$P_{av} = \frac{(t_3 - t_2)}{t_4} \times \frac{P_b}{2}$$

P_{av} = Average dynamic brake resistor dissipation, in watts

$t_3 - t_2$ = Elapsed time to decelerate from rated speed to 0 speed, in seconds

t_4 = Total cycle time or period of process, in seconds

P_b = Peak braking power, in watts

The Dynamic Brake Resistor power rating of the Dynamic Brake Module (singly or two in parallel) that will be chosen must be greater than the value calculated in Step 5. If it is not, then a Brake Chopper Module with the suitable Dynamic Brake Resistor must be specified for the application.

Step 6 – Calculate Percent Average Load

The calculation of AL is the Dynamic Brake Resistor load expressed as a percent. Pdb is the sum of the Dynamic Brake Module dissipation capacity and is obtained from the table in Step 4. This will give a data point for a line to be drawn on the curve in Figure 3. The number calculated for AL must be less than 100%. If AL is greater than 100%, an error was made in a calculation or the wrong Dynamic Brake Module was selected.

$$AL = \frac{P_{av}}{P_{db}} \times 100$$

AL = Average load in percent of Dynamic Brake Resistor

P_{av} = Average dynamic brake resistor dissipation calculated in Step 5 (Watts)

P_{db} = Steady state power dissipation capacity of resistors obtained from the table in Step 4 (Watts)

Step 7 – Calculate Percent Peak Load

The calculation of PL in percent gives the percentage of the instantaneous power dissipated by the Dynamic Brake Resistors relative to the steady state power dissipation capacity of the resistors. This will give a data point to be drawn on the curve of Figure 3. The number calculated for PL will commonly fall between 300% and 600% for the Dynamic Brake Modules. A calculated number for PL of less than 100% indicates that the Dynamic Brake Resistor has a higher steady state power dissipation capacity than is necessary.

$$PL = \frac{P_b}{P_{db}} \times 100$$

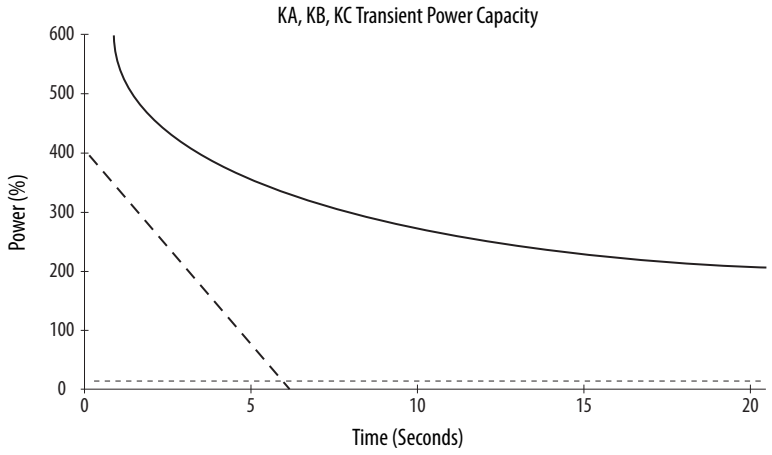
PL = Peak load in percent of Dynamic Brake Resistor

P_{av} = Peak braking power calculated in Step 2 (Watts)

P_{db} = Steady state power dissipation capacity of resistors obtained from the table in Step 4 (Watts)

Step 8 – Plot PL and AL on Curve

Draw a horizontal line equal to the value of AL (Average Load) in percent as calculated in Step 6. This value must be less than 100%. Pick a point on the vertical axis equal to the value of PL (Peak Load) in percent as calculated in Step 7. This value should be greater the 100%. Draw a vertical line at $(t_3 - t_2)$ seconds such that the line intersects the AL line at right angles. Label the intersection Point 1. Draw a straight line from PL on the vertical axis to Point 1 on the AL line. This line is the power curve described by the motor as it decelerates to minimum speed.



If the line you drew lies to the left of the constant temperature power curve of the Dynamic Brake Resistor, then there will be no application problem. If any portion of the line lies to the right of the constant temperature power curve of the Dynamic Brake Resistor, then there is an application problem. The application problem is that the Dynamic Brake Resistor is exceeding its rated temperature during the interval that the transient power curve is to the right of the resistor power curve capacity. It would be prudent to parallel another Dynamic Brake Module or apply a Brake Chopper Module with a separate Dynamic Brake Resistor.

Sizing the Chopper and Resistors

Chopper and Resistors (no longer a Rockwell Automation product)

Sizing the chopper module is the same as the dynamic brake module with a couple of added steps. Since the chopper is separate from the resistors, an additional calculation for current needs to be made. Additionally a calculation for watt-seconds or joules needs to be made for resistor sizing.

Step 1 – Determine the Total Inertia

$J_T = J_m + GR^2 \times J_L$

J_T = Total inertia reflected to the motor shaft, kilogram-meters2, kg•m^2, or pound-feet2, lb•ft^2

J_m = motor inertia, kilogram-meters2, kg•m^2, or pound-feet2, lb•ft^2

GR^2 = the gear ratio for any gear between motor and load, dimensionless

J_L = load inertia, kilogram-meters2, kg•m^2, or pound-feet2, lb•ft^2 (1.0 lb•ft^2 = 0.04214011 kg•m^2)

Step 2 – Calculate the Peak Braking Power

$$P_b = \frac{J_T \times \omega^2}{t_3 - t_2}$$

J_T = Total inertia reflected to the motor shaft, kg•m^2

ω = rated angular rotational speed, $Rad/s = \frac{2\pi N}{60}$

N = Rated motor speed, RPM

$t_3 - t_2$ = total time of deceleration from the rated speed to 0 speed, seconds

P_b = peak braking power, watts (1.0HP = 746 Watts)

Compare the peak braking power to that of the rated motor power, if the peak braking power is greater that 1.5 times that of the motor, then the deceleration time, $(t_3 - t_2)$, needs to be increased so that the drive does not go into current limit. Use 1.5 times because the drive can handle 150% current maximum for 3 seconds.

Peak power can be reduced by the losses of the motor and inverter.

Step 3 – Calculating the Maximum Dynamic Brake Resistance Value

$$R_{db1} = \frac{V_d^2}{p_b}$$

V_d = The value of DC bus voltage that the chopper module regulates at and will equal 375V DC, 750V DC, or 937.5V DC

P_b = The peak braking power calculated in Step 2

R_{db1} = The maximum allowable value for the dynamic brake resistor

The choice of the Dynamic Brake resistance value should be less than the value calculated in Step 3. If the value is greater than the calculated value, the drive can trip on DC bus overvoltage. Remember to account for resistor tolerances.

Step 4 – Choosing the Chopper Module

$$I_{dl} = \frac{V_d}{R_{dbl}}$$

I_{dl} = The minimum current flowing through the chopper module transistor

V_d = The value of DC bus voltage chosen in Step 3

R_{dbl} = The value of the dynamic brake resistor calculated in Step 3

The value of I_{d1} sets the minimum value of current rating for the Chopper Module. When the Chopper Module choice has been made, the current rating of the Module Transistor must be greater than or equal to the calculated value for I_{d1}. See the table below for rating values.

Drive Voltage (Volts AC)	Turn-On Voltage (Volts DC)	Cat. No.	Peak Transistor Current Rating (Amps)	Minimum DB Resistor Value (Ohms)
230	375	WA018	50	9.0
		WA070	200	2.3
		WA115	400	1.25
460	750	WB009	25	37
		WB035	100	9.0
		WB110	400	2.5
575	935	WC009	25	46
		WC035	75	15.5
		WC085	400	3.0

Step 5 – Determine the Minimum Resistance

Each chopper module in the table above has a minimum resistance associated with it. If a resistance lower than the value show in the table is connected to the chopper module, the brake transistor will most likely be damaged.

Step 6 – Choosing the Dynamic Brake Resistance Value

To avoid damage to this transistor and get the desired braking performance, select a resistor with a resistance between the maximum resistance calculated in Step 3 and the minimum resistance of the selected chopper module.

Step 7 – Estimating the Minimum Wattage requirements for the Dynamic Brake Resistor

It is assumed that the application exhibits a periodic function of acceleration and deceleration. If $(t_3 - t_2)$ = the time in seconds necessary for deceleration from rated speed to 0 speed, and t_4 is the time in seconds before the process repeats itself, then the average duty cycle is $(t_3 - t_2)/t_4$. The power as a function of time is a linearly decreasing function from a value equal to the peak regenerative power to 0 after $(t_3 - t_2)$ seconds have elapsed. The average power regenerated over the interval of $(t_3 - t_2)$ seconds is Pb/2. The average power in watts regenerated over the period t_4 is:

$$P_{av} = \frac{(t_3 - t_2)}{t_4} \times \frac{P_b}{2}$$

P_{av} = average dynamic brake resistor dissipation, watts

$t_3 - t_2$ = Elapsed time to decelerate from rated speed to 0 speed, seconds

t_4 = Total cycle time or period of process, seconds

P_b = Peak braking power, watts

The Dynamic Brake Resistor power rating in watts that will be chosen should be equal to or greater than the value calculated in Step 7.

Step 8 – Calculate the requires Watt-Seconds (joules) for the resistor

In order to be sure that the resistors thermal capabilities are not violated, a calculation to determine the amount of energy dissipated into the resistor will be made. This will determine the amount joules the resistor must be able to absorb.

$$P_{ws} = (t_3 - t_2) \times \frac{P_b}{2}$$

P_{ws} = Required watt - seconds of the resistor

$t_3 - t_2$ = Elapsed time to decelerate from ωb speed to ω0 speed, seconds

P_b = Peak braking power, watts

Internal Brake IGBT for PowerFlex 755 Drives

Sizing Resistors for an internal DB IGBT

Sizing resistors for the internal DB IGBT Uses the same formula's as previous, and is very similar to the Chopper Module sizing.

Step 1 – Determine the Total Inertia

$$J_T = J_m + GR^2 \times J_L$$

J_T = Total inertia reflected to the motor shaft, kilogram-meters2, kg•m^2, or pound-feet2, lb•ft^2

J_m = motor inertia, kilogram-meters2, kg•m^2, or pound-feet2, lb•ft^2

GR = The gear ratio for any gear between motor and load, dimensionless

J_L = load inertia, kilogram-meters2, kg•m^2, or pound-feet2, lb•ft^2 (1.0 lb•ft^2 = 0.04214011 kg•m^2)

Step 2 – Calculate the Peak Braking Power

$$P_b = \frac{J_T \times \omega^2}{t_3 - t_2}$$

J_T = Total inertia reflected to the motor shaft, kg•m^2

ω = rated angular rotational speed, $Rad/s = \frac{2\pi N}{60}$

N = Rated motor speed, RPM

$t_3 - t_2$ = total time of deceleration from the rated speed to 0 speed, seconds

P_b = peak braking power, watts (1.0HP = 746 Watts)

Compare the peak braking power to that of the rated motor power, if the peak braking power is greater that 1.5 times that of the motor, then the deceleration time, ($t_3 - t_2$), needs to be increased so that the drive does not go into current limit. Use 1.5 times because the drive can handle 150% current maximum for 3 seconds.

Peak power can be reduced by the losses of the motor and inverter.

Step 3 – Calculating the Maximum Dynamic Brake Resistance Value

$$R_{db1} = \frac{V_d^2}{p_b}$$

V_d = The value of DC bus voltage that the drive regulates at and will equal 375V DC, 750V DC, or 937.5V DC depending on input voltage

P_b = The peak braking power calculated in Step 2

R_{db1} = The maximum allowable value for the dynamic brake resistor

The choice of the Dynamic Brake resistance value should be less than the value calculated in Step 3. If the value is greater than the calculated value, the drive can trip on DC bus overvoltage. Remember to account for resistor tolerances.

Step 4 – Determine the Minimum Resistance

Each drive with an internal DB IGBT has a minimum resistance associated with it. If a resistance lower than the minimum value for a given drive is connected, the brake transistor will most likely be damaged. Below is a table of minimum resistances for frame 2 through 7 PowerFlex 750-Series drives.

Frame	400V				480V			
	ND kW	Catalog Code	Min Resistance	Max DB Current	ND HP	Catalog Code	Min Resistance	Max DB Current
2	0.75	C2P1	31.6	25	1.0	D2P1	31.6	25
	1.5	C3P5	31.6	25	2.0	D3P4	31.6	25
	2.2	C5P0	31.6	25	3.0	D5P0	31.6	25
	4.0	C8P7	31.6	25	5.0	D8P0	31.6	25
	5.5	C011	31.6	25	7.5	D011	31.6	25
	7.5	C015	31.6	25	10	D014	31.6	25
	11	C022	22.6	34.9	15	D022	22.6	34.9
3	15	C030	31.6	25	20	D027	31.6	25
	18.5	C037	31.6	25	25	D034	31.6	25
	22	C043	16.6	47.6	30	D040	16.6	47.6
4	30	C060	15.8	50	40	D052	15.8	50
	37	C072	15.8	50	50	D065	15.8	50
5	37	C072	7.9	100	50	D065	7.9	100
	45	C085	7.9	100	60	D077	7.9	100
	55	C104	7.9	100	75	D096	7.9	100
6	55	C104	3.3	239.4	75	D096	3.3	239.4
	75	C140	3.3	239.4	100	D125	3.3	239.4
	90	C170	3.3	239.4	125	D156	3.3	239.4
	110	C205	3.3	239.4	150	D186	3.3	239.4
	132	C260	3.3	239.4	200	D248	3.3	239.4
7	132	C260	2.4	329	200	D248	2.4	329
	160	C302	2.4	329	250	D302	2.4	329
	200	C367	2.4	329	300	D361	2.4	329
	250	C456	1.65	478.8	350	D415	1.65	478.8

Step 5 – Choosing the Dynamic Brake Resistance Value

To avoid damage to this transistor and get the desired braking performance, select a resistor with a resistance between the maximum resistance calculated in Step 3 and the minimum resistance of the drive IGBT.

Step 6 – Estimating the Minimum Wattage requirements for the Dynamic Brake Resistor

It is assumed that the application exhibits a periodic function of acceleration and deceleration. If $(t_3 - t_2)$ = the time in seconds necessary for deceleration from rated speed to 0 speed, and t_4 is the time in seconds before the process repeats itself, then the average duty cycle is $(t_3 - t_2)/t_4$. The power as a function of time is a linearly decreasing function from a value equal to the peak regenerative power to 0 after $(t_3 - t_2)$ seconds have elapsed. The average power regenerated over the interval of $(t_3 - t_2)$ seconds is Pb/2. The average power in watts regenerated over the period t_4 is:

$$P_{av} = \frac{(t_3 - t_2)}{t_4} \times \frac{P_b}{2}$$

P_{av} = Average dynamic brake resistor dissipation, in watts

$t_3 - t_2$ = Elapsed time to decelerate from rated speed to 0 speed, in seconds

t_4 = Total cycle time or period of process, in seconds

P_b = Peak braking power, in watts

The Dynamic Brake Resistor power rating in watts that will be chosen should be equal to or greater than the value calculated in Step 6.

Step 7 – Calculate the requires Watt-Seconds (joules) for the resistor

In order to be sure that the resistors thermal capabilities are not violated, a calculation to determine the amount of energy dissipated into the resistor will be made. This will determine the amount joules the resistor must be able to absorb

$$P_{ws} = (t_3 - t_2) \times \frac{P_b}{2}$$

P_{ws} = Required watt - seconds of the resistor

$t_3 - t_2$ = Elapsed time to decelerate from ωb speed to ω0 speed, seconds

P_b = Peak braking power, watts

Flux Regulator

The flux regulator is used to control and limit the overall (fundamental) voltage applied to an induction motor when FOC is used. The flux regulator controls field weakening above base speed and maintains voltage margin for a current

regulator. A variation of the induction motor flux regulator is used for PM motors for operation above base speed.

As default the flux regulator is enabled. When disabled, the current regulator becomes de-tuned.

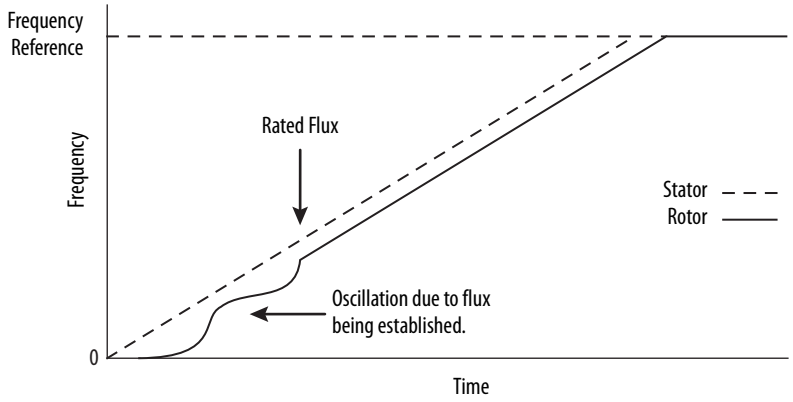
This regulator should never be disabled. If you feel you need to disable this function, you should consult the factory for verification.

Flux Up

AC induction motors require flux to be established before controlled torque can be developed. To build flux, voltage is applied. There are two methods to flux the motor.

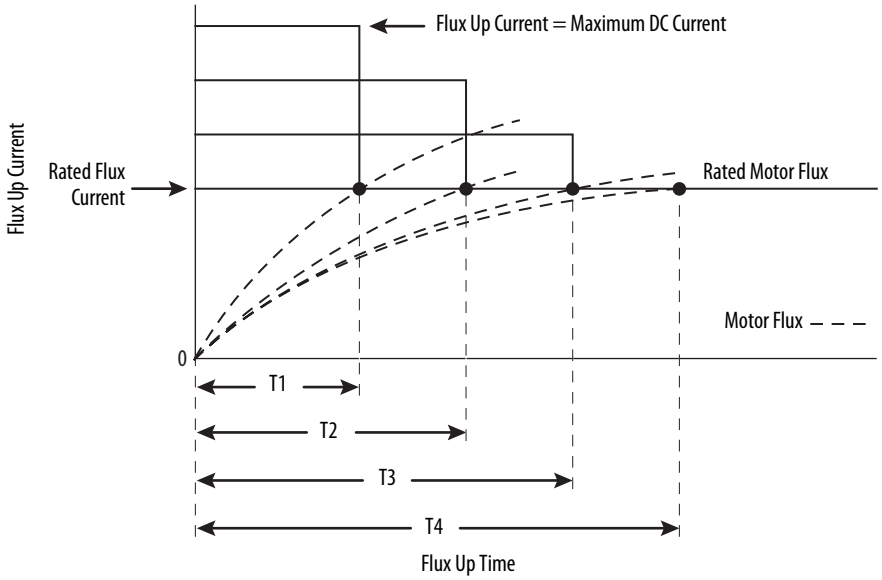
The first method is Automatic during a normal start. Flux is established as the output voltage and frequency are applied to the motor. While the flux is being established, the unpredictable nature of the developed torque may cause the rotor to oscillate even though acceleration of the load may occur. In the motor, the acceleration profile may not follow the commanded acceleration profile due to the lack of developed torque.

Figure 16 - Accel Profile during Normal Start - No Flux Up



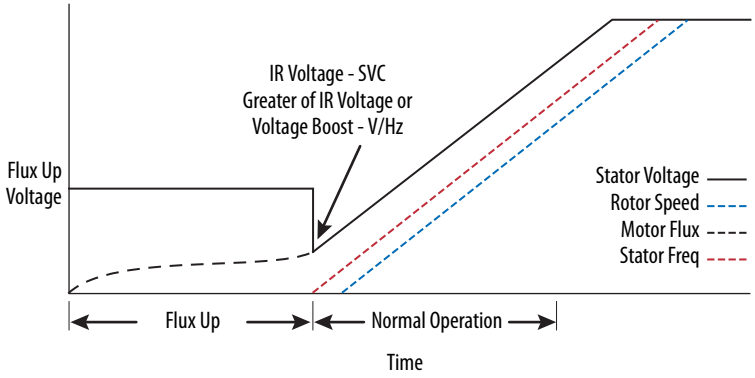
The second method is Manual. In this mode, DC current is applied to the motor so that the flux is established before rotation. The flux up time period is based on the level of flux up current and the rotor time constant of the motor. The flux up current is not user adjustable.

Figure 17 - Flux Up Current versus Flux Up Time



Once rated flux is reached in the motor, normal operation begins and the desired acceleration profile is achieved.

Rated Flux Reached



Once rated flux is reached in the motor, normal operation begins and the desired acceleration profile is achieved.

Parameters

File	Group	No.	Display Name Full Name Description	Values		Read-Write	Data Type
MOTOR CONTROL	Mtr Ctrl Options	43	**Flux Up Enable** Flux Up Enable "Manual" (0) – Flux is established for P44 [Flux Up Time] before initial acceleration. "Automatic" (1) – Flux is established for a calculated time period based on motor nameplate data before acceleration. P44 [Flux Up Time] is not used.	Default: Options:	1 = "Automatic" 0 = "Manual" 1 = "Automatic"	RW	32-bit Integer
		44	**Flux Up Time** Flux Up Time The amount of time the drive will use to try to achieve full motor stator flux. When a Start command is issued, DC current at P26 [Motor NP Amps] level is used to build stator flux before accelerating.	Units: Default: Min/Max:	Secs 0.0000 0.0000 / 5.0000	RW	Real

Applications

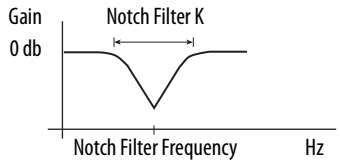
This function is usually associated with applications that require extended acceleration times. Out of the box, the drive is set to 'Automatic' and will attempt to get full motor stator flux based on motor nameplate information. In some cases the loading and ramp curve during acceleration could have an adverse affect on the drive's thermal manager. Some applications include mining conveyors or large centrifuges. This function gives you the ability to manually be sure the motor stator is fully fluxed up before acceleration by manually assigning a flux up time. It can produce a better acceleration at low frequencies without excessive current.

Notch Filter

A notch filter exists in the torque reference loop to reduce mechanical resonance created by a gear train. P687[Notch Fltr Freq] sets the center frequency for the 2 pole notch filter, and [Notch Fltr Atten] Sets the attenuation of the notch filter located in the Vector control torque reference section. Attenuation is the ratio of the notch filter input signal to its output at the P687[Notch Fltr Freq]. An attenuation of 30 means that the notch output is 1/30th of the input at the specified frequency.

The notch filter is valid only in Flux Vector Motor Control modes (P35).

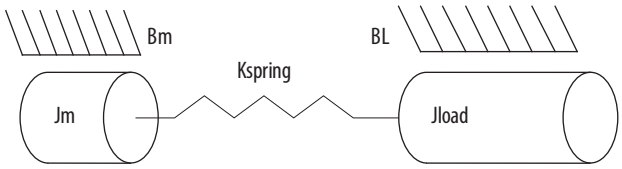
Figure 18 - Notch Filter Frequency



Example

A mechanical gear train consists of two masses (the motor and the load) and spring (mechanical coupling between the two loads).

Mechanical Gear Train



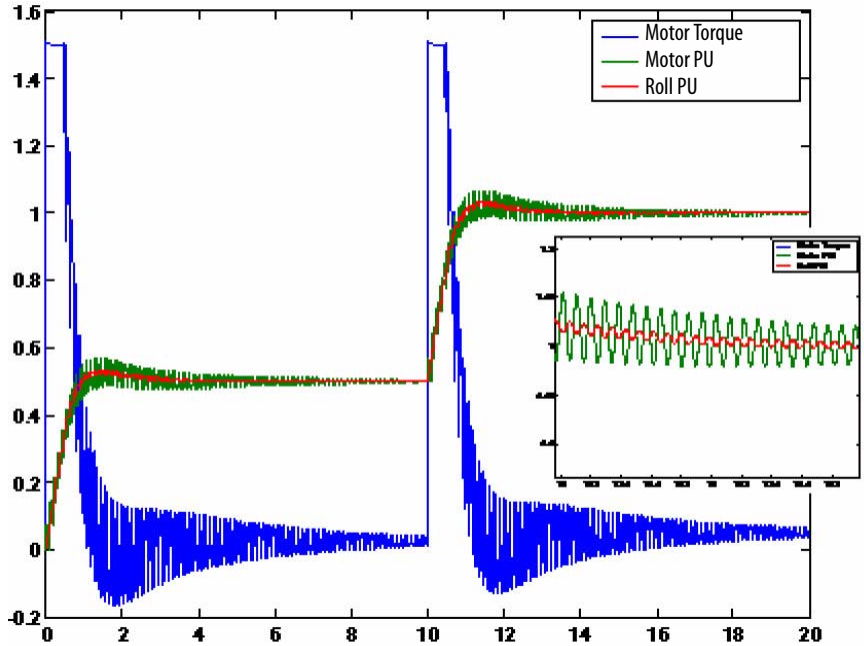
The resonant frequency is defined by the following equation:

$$ResonanceHz = \sqrt{Kspring \times \frac{(Jm + Jload)}{(Jm \times Jload)}}$$

- Jm is the motor inertia (seconds)
- Jload is the load inertia (seconds)
- Kspring is the coupling spring constant (rad2 / sec)

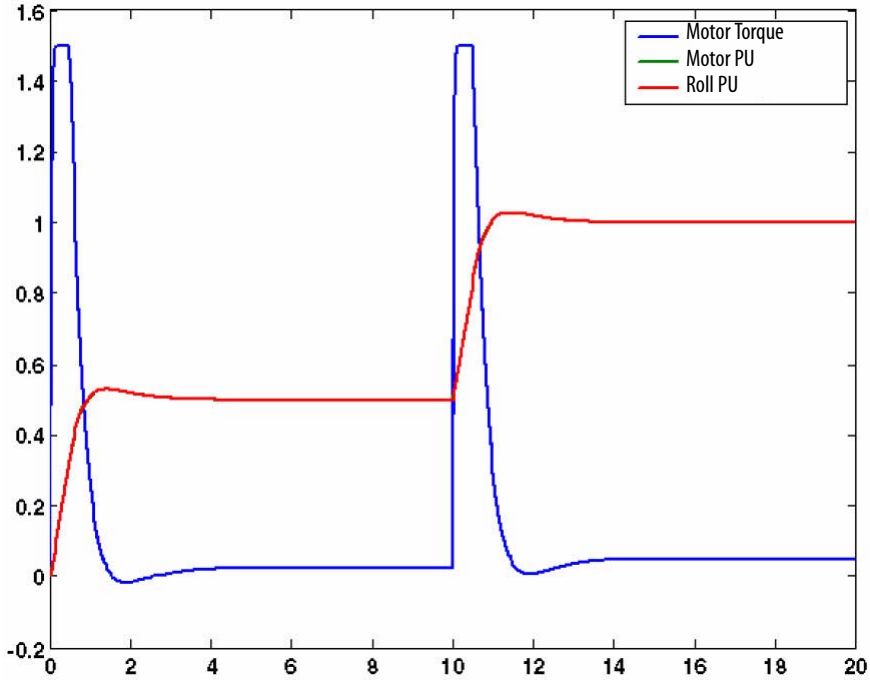
The following graph shows a two mass system with a resonant frequency of 62 radians/second (9.87 Hz). One Hertz is equal to 2p radians/second.

Figure 19 - Resonance

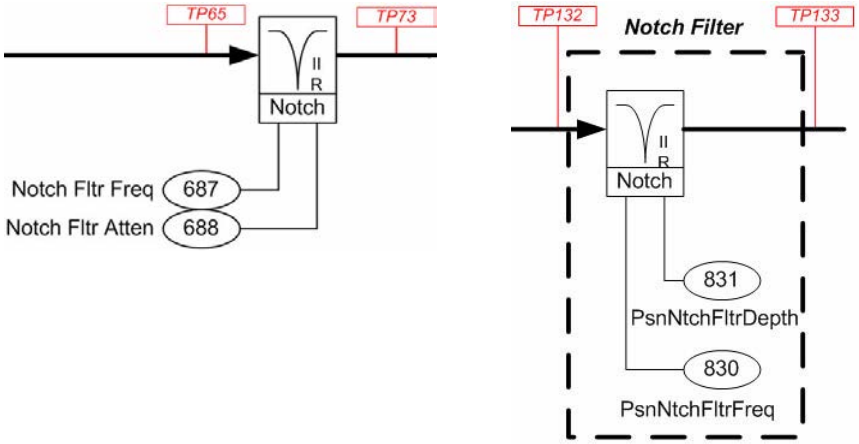


The following represents the same mechanical gear train but with [Notch Filter Freq] set to 10.

Figure 20 - 10 Hz Notch



To see the effects of the notch filter use test points T65 and T73 in torque control. T65 is before the filter and T73 after. And test point Txx (before) and Txx (after) in position control. See the partial block diagram below.



Regen Power Limit

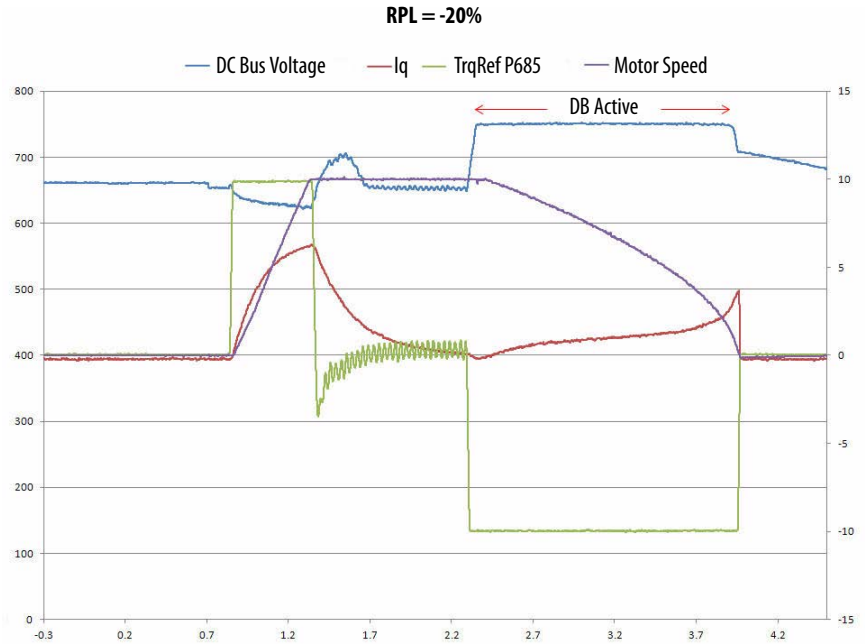
The P426 [Regen Power Lmt] is programmed as a percentage of the rated power. The mechanical energy that is transformed into electrical power during a deceleration or overhauling load condition is clamped at this level. Without the proper limit, a bus overvoltage may occur. When using the bus regulator [Regen Power Lim] can be left at factory default, -50%.

When using dynamic braking or a regenerative supply, [Regen Power Lim] can be set to the most negative limit possible (–800%). When you have dynamic braking or regenerative supply, but want to limit the power to the dynamic brake or regenerative supply, [Regen Power Lim] you can set a specific level. Values in this parameter are valid only in a Flux Vector mode.

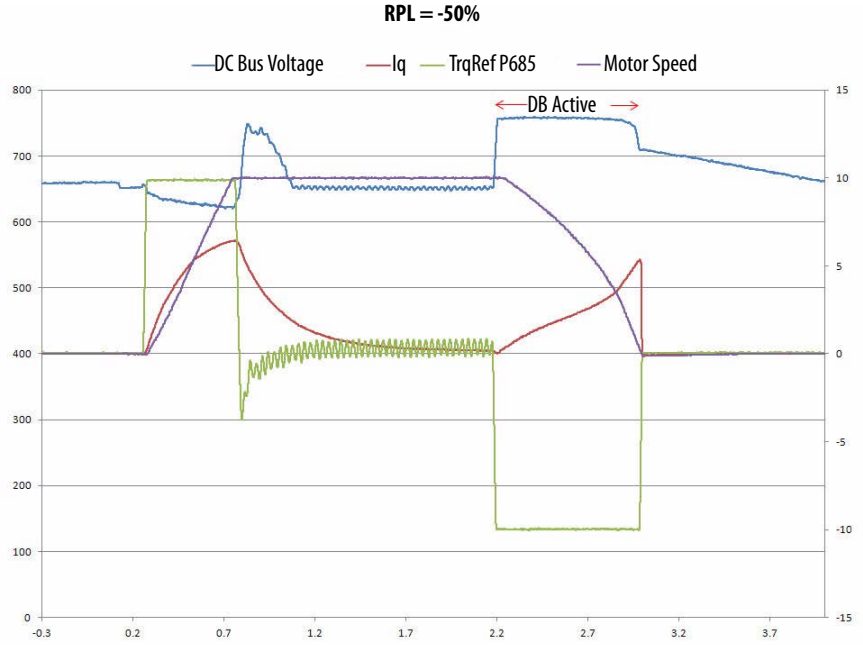
The following series of plots describes the difference between changing Regen Power Limit versus changing the Negative Torque Limit. The beginning part of every plot is identical, this is the acceleration of the motor. Once the stop is commanded and deceleration begins, note the red trace in each. This represents torque current. Since power is proportional to speed, as the speed decreases, the torque current increases allowing more power to be dissipated.

Note the speed feedback in the RPL = -20%, the slower the motor gets the faster it's brought to zero speed and the torque current increases. The higher the value in Regen Power Limit the more power is allow to pass through.

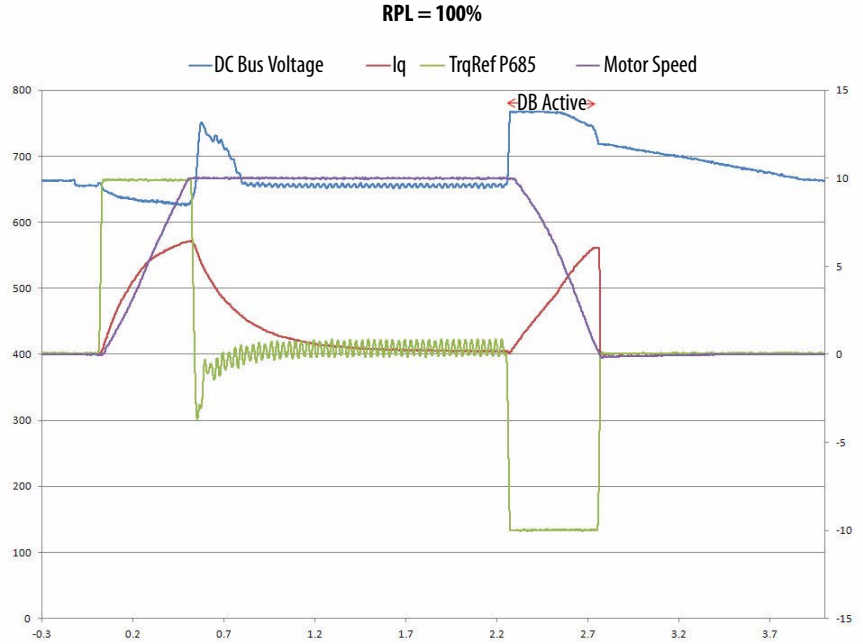
Focus on the torque current (red) trace as you scroll through the plots and note the change in the shape as the regen power limit was increase. Then see how it is clamped at a particular level when Negative Torque Limit is changed.



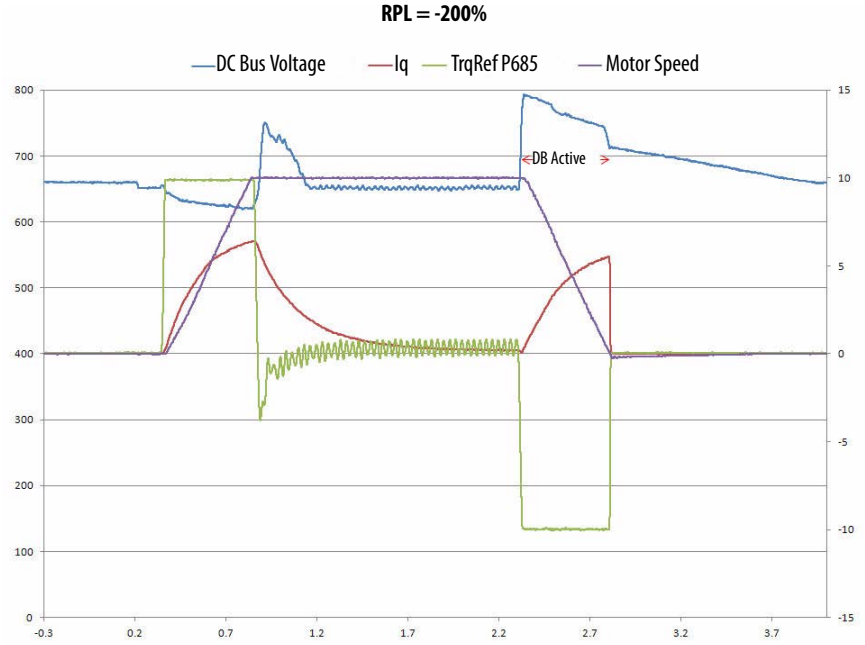
RPL = -50%



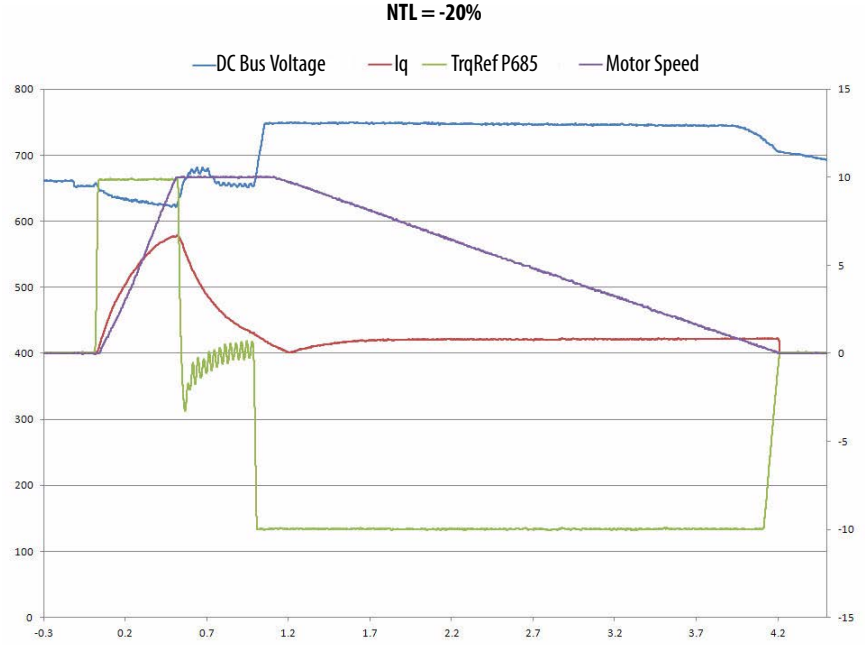
RPL = 100%

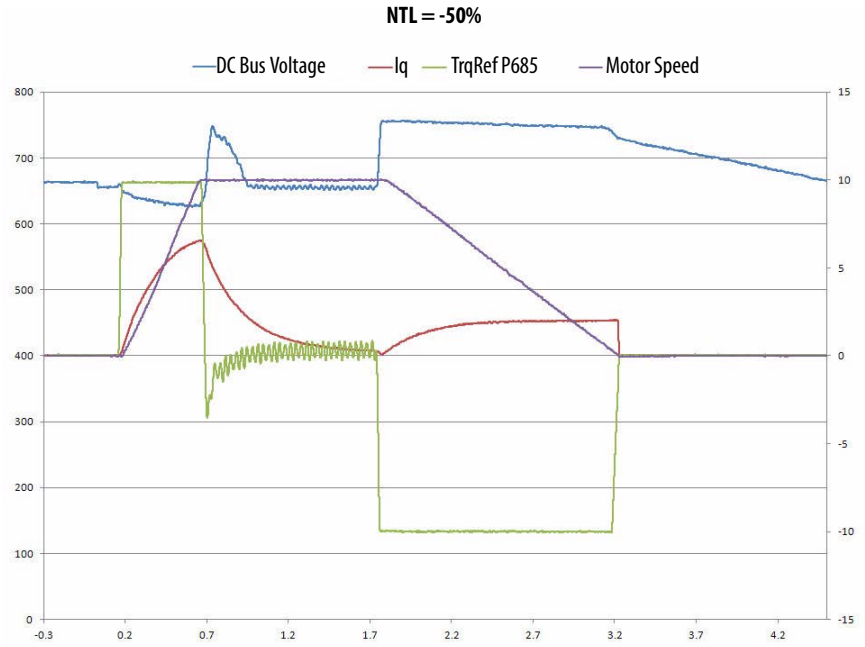


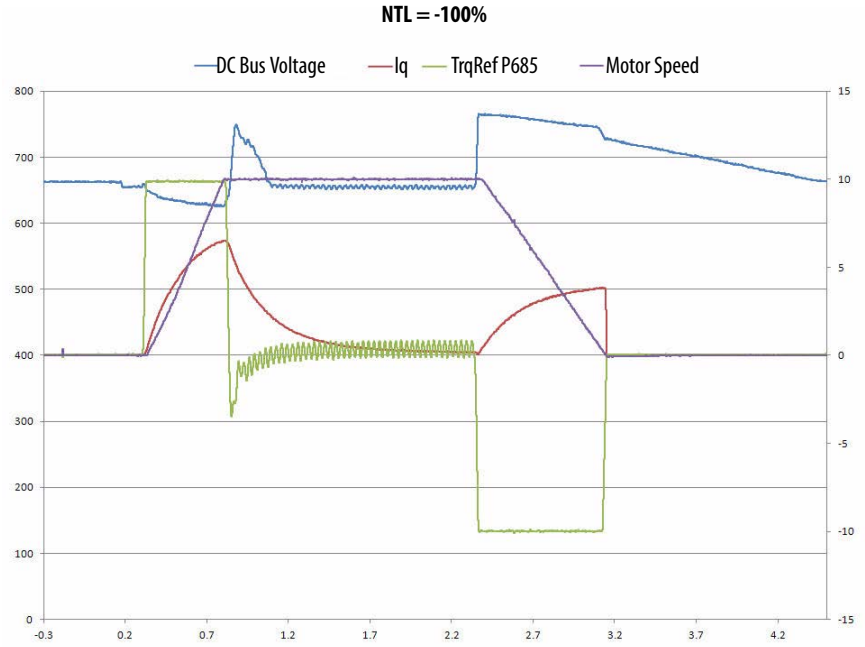
RPL = -200%



NTL = -20%




NTL = -50%
DC Bus Voltage
Iq
TrqRef P685
Motor Speed
800
700
600
500
400
300
200
100
0
15
10
5
0
-5
-10
-15
-0.3
0.2
0.7
1.2
1.7
2.2
2.7
3.2
3.7
4.2

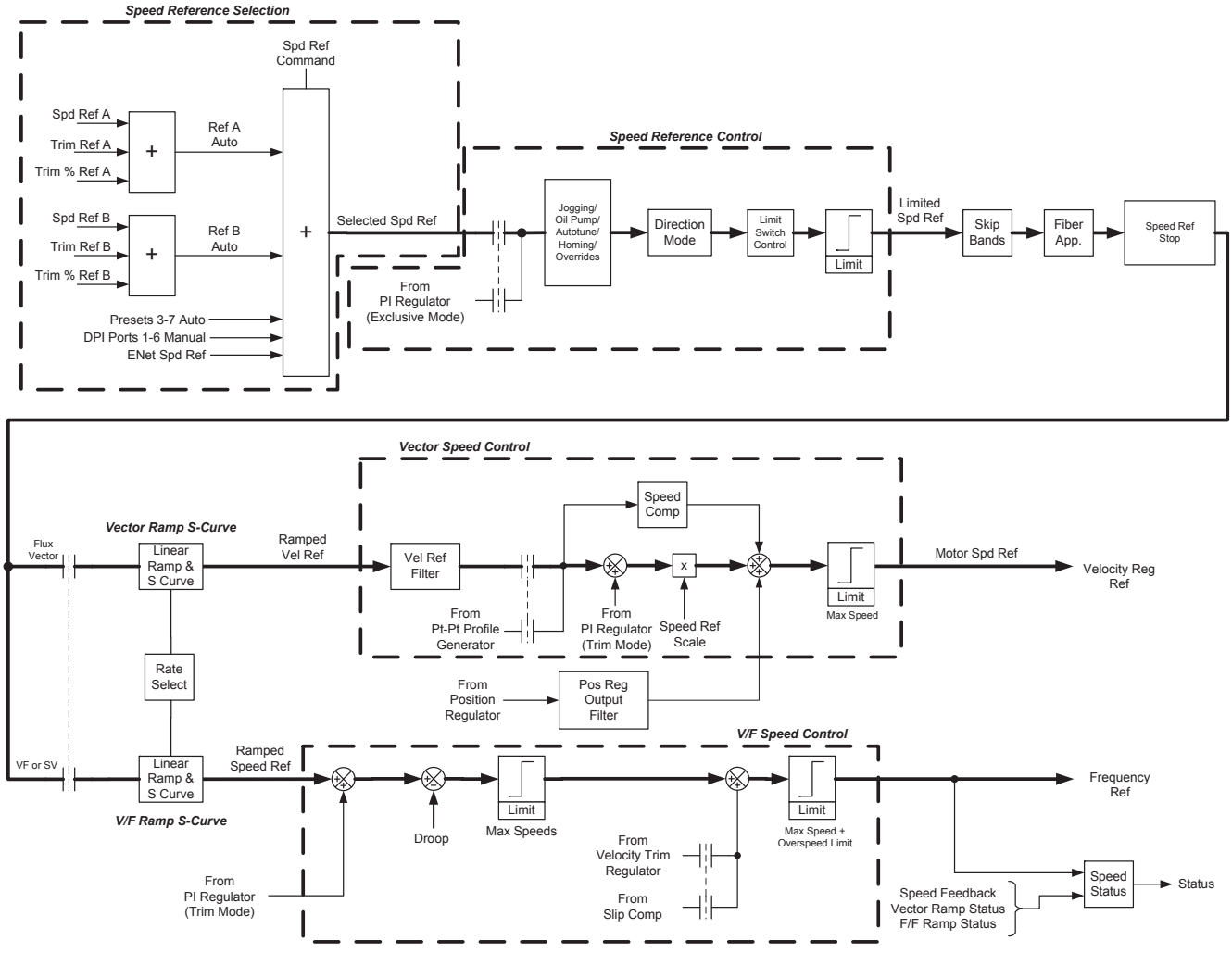

NTL = -100%
DC Bus Voltage
Iq
TrqRef P685
Motor Speed
800
700
600
500
400
300
200
100
0
15
10
5
0
-5
-10
-15
-0.3
0.2
0.7
1.2
1.7
2.2
2.7
3.2
3.7
4.2

Speed Reference

The speed reference can come from a variety of sources. Some may be selected through digital inputs or via bit manipulation of the Network Logic Command Word:

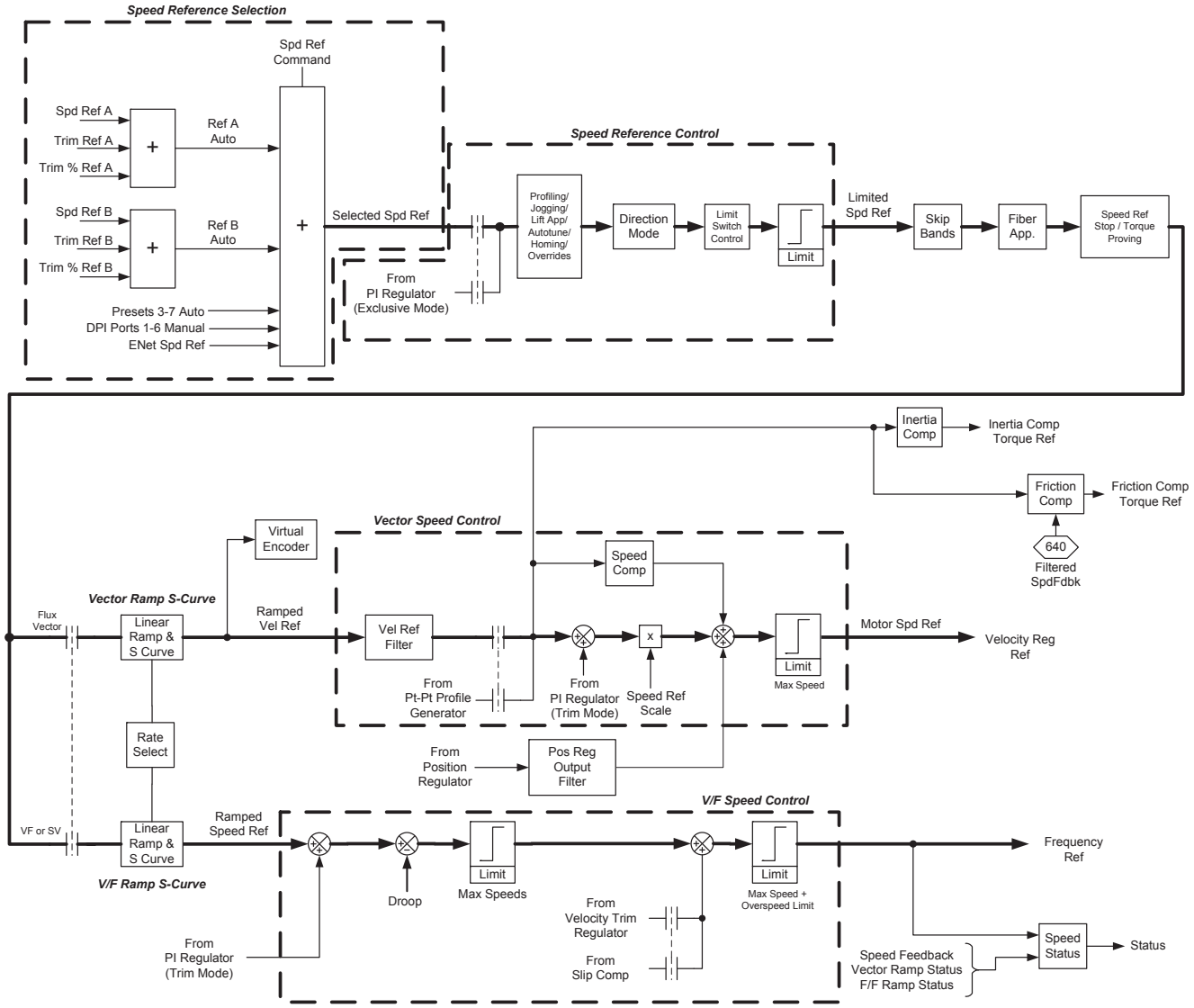
- HIM (local or remote)
- Analog Input
- Preset Speed Parameters
- Jog Speed Parameters
- Auxiliary Velocity Feedback
- Network Communication
- Process PID Loop
- MOP Reference
- DeviceLogix software

Figure 21 - PowerFlex 753 Speed Reference Selection Overview



Refer to the PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001, Appendix A for more details on the PowerFlex 753 Control Block Diagrams.

Figure 22 - PowerFlex 755 Speed Reference Selection Overview



Refer to the PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001, Appendix A, for more details on the PowerFlex 755 Control Block Diagrams.

Network Reference

Speed Reference A is the normal speed reference used. To choose a source for this reference, make a selection in P545 [Speed Ref A Sel]. Also, when the network (Logic Command Word) is used as the speed reference, refer to the following documentation for details of operation:

- PowerFlex 750-Series AC Drives Programming Manual, 750-PM001
- PowerFlex 755 Drive Embedded EtherNet/IP Adapter User Manual, 750COM-UM001
- PowerFlex 20-750-ENETR Dual-port EtherNet/IP Option Module User Manual, 750COM-UM008
- EtherNet/IP Network Configuration User Manual, ENET-UM001

The Reference is a 32-bit REAL (floating point) piece of control data produced by the controller and consumed by the adapter. The Feedback is a 32-bit REAL (floating point) piece of status data produced by the adapter and consumed by the controller.

When using a ControlLogix controller, the 32-bit REAL Reference is always DINT 1 in the output image and the 32-bit REAL Feedback is always:

- DINT 1 in the input image when using the drive Add-On Profile.
- DINT 2 when using the Generic Profile.

For a PLC-5®, SLC™ 500 or MicroLogix™ 1100/1400 controller, the 32-bit REAL Reference word is always words 2 (Least Significant Word) and 3 (Most Significant Word) in the output image and the 32-bit REAL Feedback is always words 2 (Least Significant Word) and 3 (Most Significant Word) in the input image.

When using a drive Add-On Profile, the Reference and Feedback are automatically formatted properly and displayed as a controller tag. When using the Generic Profile, the I/O image is integer-based and the Reference and Feedback are floating point. Because of this, a COP (Copy) instruction or User Defined Data Type (UDDT) is required to correctly write values to the Reference and read values from the Feedback. Refer to the PowerFlex 755 Embedded EtherNet/IP Adapter User Manual or to the PowerFlex 20-750-ENETR Dual-port EtherNet/IP Option Module User Manual for ladder logic program examples.

When using the drive Add-On Profile, the controller tags for Reference and Feedback are automatically and properly formatted. This eliminates the need for data conversion using COP (copy) instructions or a UDDT to copy the DINT data into a REAL word.

The Reference and Feedback 32-bit REAL value represents drive speed. The scaling for the speed Reference and Feedback is dependent on drive P300 [Speed Units]. For example, if P300 is set to Hz, a 32-bit REAL Reference value of 30.0 would equal a Reference of 30.0 Hz. If P300 is set to RPM, a 32-bit REAL

Reference value of 1020.5 would equal a Reference of 1020.5 RPM. Note that the commanded maximum speed can never exceed the value of drive P520 [Max Fwd Speed]. Table 8 shows example References and their results for a PowerFlex 755 drive that has its:

- P300 [Speed Units] set to Hz.
- P37 [Maximum Freq] set to 130 Hz.
- P520 [Max Fwd Speed] set to 60 Hz.

When P300 [Speed Units] is set to RPM, the other parameters are also in RPM.

Table 8 - PowerFlex 755 Drive Example Speed Reference/Feedback Scaling

Network Reference Value	Speed Command Value(2)	Output Speed	Network Feedback Value
130.0	130 Hz	60 Hz(3)	60.0
65.0	65 Hz	60 Hz(3)	60.0
32.5	32.5 Hz	32.5 Hz	32.5
0.0	0 Hz	0 Hz	0.0
-32.5(1)	32.5 Hz	32.5 Hz	32.5

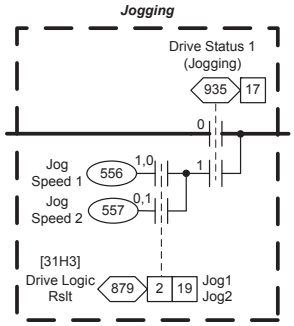
(1) The effects of values less than 0.0 depend on whether the PowerFlex 755 drive uses a Bipolar or Unipolar Direction mode. See the drive documentation for details.
(2) For this example, drive P300 [Speed Units] is set to Hz.
(3) The drive runs at 60 Hz instead of 130 Hz or 65 Hz because drive P520 [Max Fwd Speed] sets 60 Hz as the maximum speed

When a network (communication adapter) is selected as the speed reference, a 32-bit word is used as the speed reference. If P308 [Direction Mode], is set to 1 "Bipolar," the most significant bit (MSB) is used for direction control. Otherwise, the MSB is ignored.

IMPORTANT When a 20-COMM Carrier (20-750-20COMM) is used to install a 20-COMM adapter on a PowerFlex 750-Series drive, the upper word (Bits 16…31) of the Logic Command Word and Logic Status Word are not accessible. The upper word is only used and accessible on PowerFlex 750-Series communication modules (20-750-*) and the embedded EtherNet/IP on PowerFlex 755 drives.

Jog

When the drive is not running, pressing the HIM's Jog soft button or a programmed Jog digital input function or by Logic Command (sent over a communication network) will cause the drive to jog at a separately programmed jog reference. This jog speed reference value is entered in P556 [Jog Speed 1] or P557 [Jog Speed 2].

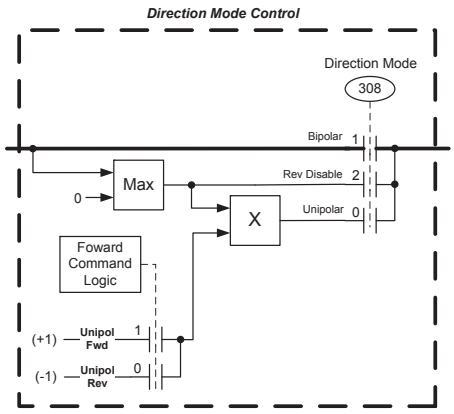


Scaling of an Analog Speed Reference

Refer to Analog Inputs on page 85.

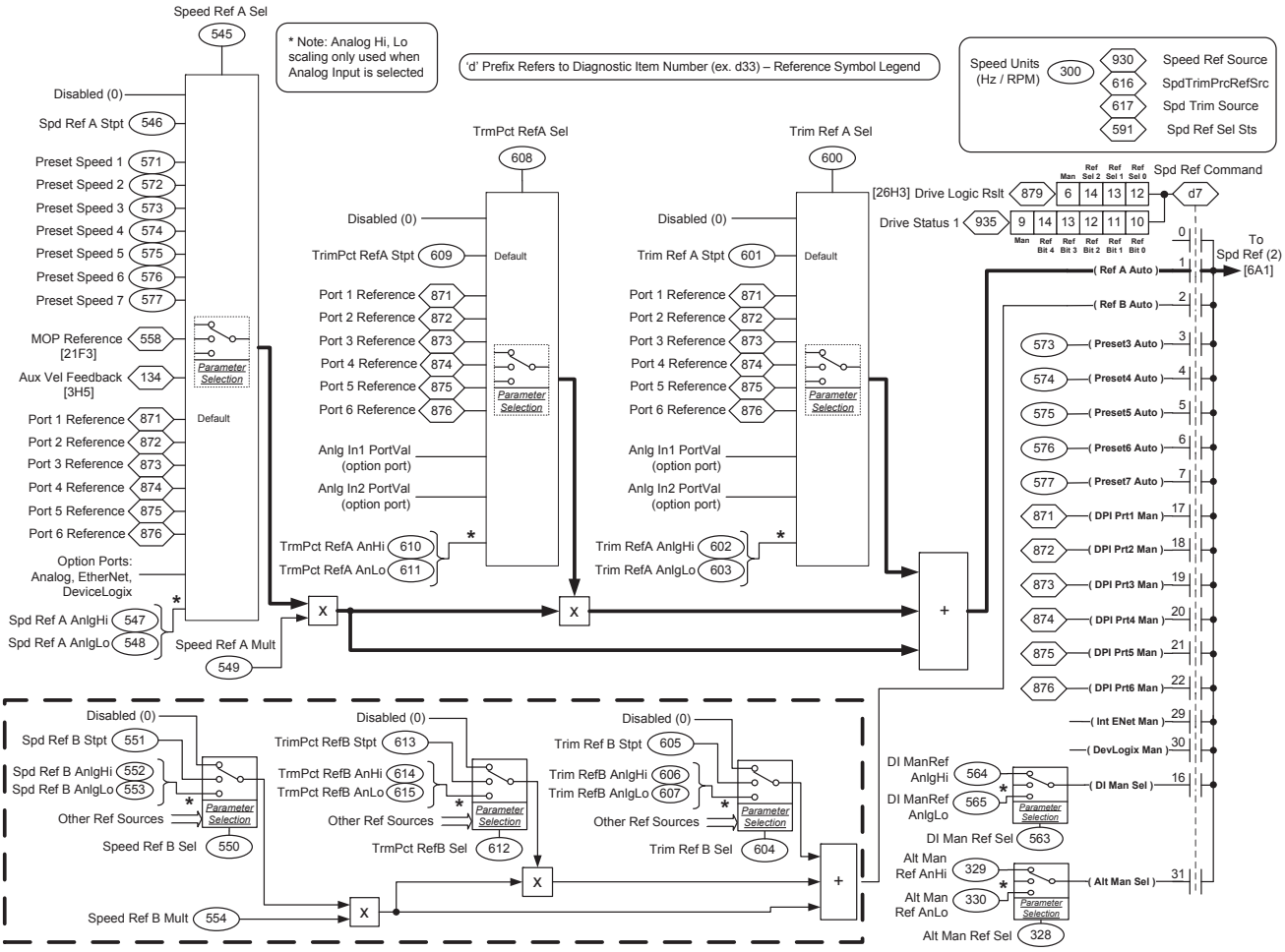
Polarity

The polarity configuration can be selected as unipolar, bipolar, or reverse disabled via P307 [Direction Mode]. When in Unipolar mode, the sign of the speed reference value (and therefore direction of motor rotation) is determined by P879 [Drive Logic Rslt] Bit 4 "Forward" and Bit 5 "Reverse." When in Bipolar mode, the sign of the speed reference value will determine the direction of motor rotation. When in Reverse Disable mode, negative speed reference values are rejected and a zero speed value is used in their place.



Trim

The speed reference source, specified in P545 [Speed Ref A Sel] or P550 [Speed Ref B Sel], can be trimmed by variable amount. You have the option to trim the speed reference by a percentage of the reference and/or by a fixed amount and can dictate whether it is a positive or negative value. Refer to the PowerFlex 750-Series Trim Block Diagram below.


Speed Ref A Sel
545
* Note: Analog Hi, Lo scaling only used when Analog Input is selected
'd' Prefix Refers to Diagnostic Item Number (ex. d33) – Reference Symbol Legend
Speed Units (Hz / RPM) 300
930 Speed Ref Source
616 SpdTrimPrcRefSrc
617 Spd Trim Source
591 Spd Ref Sel Sts
Disabled (0)
Spd Ref A Stpt 546
Preset Speed 1 571
Preset Speed 2 572
Preset Speed 3 573
Preset Speed 4 574
Preset Speed 5 575
Preset Speed 6 576
Preset Speed 7 577
MOP Reference [21F3] 558
Aux Vel Feedback [3H5] 134
Port 1 Reference 871
Port 2 Reference 872
Port 3 Reference 873
Port 4 Reference 874
Port 5 Reference 875
Port 6 Reference 876
Option Ports: Analog, EtherNet, DeviceLogix
Spd Ref A AnlgHi 547
Spd Ref A AnlgLo 548
Speed Ref A Mult 549
Parameter Selection
Default
TrmPct RefA Sel
608
TrimPct RefA Stpt 609
TrmPct RefA AnHi 610
TrmPct RefA AnLo 611
Anlg In1 PortVal (option port)
Anlg In2 PortVal (option port)
Trim Ref A Sel
600
Trim Ref A Stpt 601
Trim RefA AnlgHi 602
Trim RefA AnlgLo 603
[26H3] Drive Logic Rslt 879
Drive Status 1 935
Spd Ref Command
d7
To Spd Ref (2) [6A1]
(Ref A Auto)
(Ref B Auto)
573 (Preset3 Auto)
574 (Preset4 Auto)
575 (Preset5 Auto)
576 (Preset6 Auto)
577 (Preset7 Auto)
871 (DPI Prt1 Man)
872 (DPI Prt2 Man)
873 (DPI Prt3 Man)
874 (DPI Prt4 Man)
875 (DPI Prt5 Man)
876 (DPI Prt6 Man)
(Int ENet Man)
(DevLogix Man)
(DI Man Sel)
(Alt Man Sel)
Spd Ref B Stpt 551
Spd Ref B AnlgHi 552
Spd Ref B AnlgLo 553
Other Ref Sources
Speed Ref B Sel 550
Speed Ref B Mult 554
TrimPct RefB Stpt 613
TrmPct RefB AnHi 614
TrmPct RefB AnLo 615
TrmPct RefB Sel 612
Trim Ref B Stpt 605
Trim RefB AnlgHi 606
Trim RefB AnlgLo 607
Trim Ref B Sel 604
DI ManRef AnlgHi 564
DI ManRef AnlgLo 565
DI Man Ref Sel 563
Alt Man Ref AnHi 329
Alt Man Ref AnLo 330
Alt Man Ref Sel 328

Example 1

The following example shows the configuration and resultant of the percent trim function:

- P545 [Speed Ref A Sel] = P546 [Spd Ref A Stpt]
- P546 [Spd Ref A Stpt] = 20.00 Hz
- P608 [TrmPct RefA Sel] = P609 [TrmPct RefA Stpt]
- P609 [TrmPct RefA Stpt] = 25%
- P2 [Commanded SpdRef] = 25.00 Hz

If the speed reference = 20 Hz and if the trim percentage = 25%, the resulting trim will be 20 Hz x 25% = 5 Hz, which when added to the speed reference would = 25 Hz. As the speed reference changes, the amount of trim also changes since it is a percent of the speed reference. If the trim percentage = -25%, then the resulting trim will be 20 Hz x -25% = -5 Hz, the speed reference would = 15 Hz.

Example 2
The following example shows the configuration and resultant of the fixed amount trim function:

- P545 [Speed Ref A Sel] = P546 [Spd Ref A Stpt]
- P546 [Spd Ref A Stpt] = 20.00 Hz
- P600 [Trim Ref A Sel] = P601 [Trim Ref A Stpt]
- P601 [Trim Ref A Stpt] = 10.00 Hz
- P2 [Commanded SpdRef] = 30.00 Hz

If the speed reference = 20 Hz, and if the trim set point = 10 Hz, the speed reference would be 20 Hz + 10 Hz = 30 Hz. If the trim set point = -10 Hz, then the speed reference would = 10 Hz.

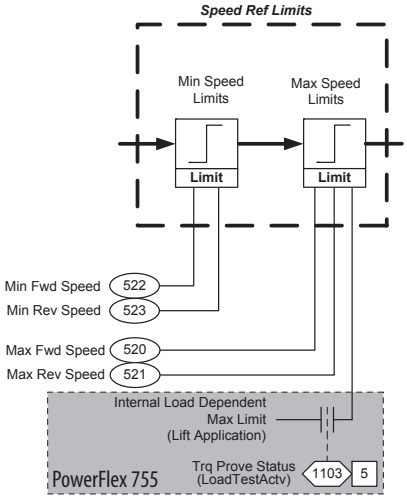
Example 3
The following example shows the configuration and resultant of utilizing both the perfect and fixed amount trim function:

- P545 [Speed Ref A Sel] = P546 [Spd Ref A Stpt]
- P546 [Spd Ref A Stpt] = 20.00 Hz
- P608 [TrmPct RefA Sel] = P609 [TrmPct RefA Stpt]
- P609 [TrmPct RefA Stpt] = 25%
- P600 [Trim Ref A Sel] = P601 [Trim Ref A Stpt]
- P601 [Trim Ref A Stpt] = 10.00 Hz
- P2 [Commanded SpdRef] = 35.00 Hz

If the speed reference = 20Hz, and if the trim percentage = 25%, that resulting trim will be 20 Hz x 25% = 5 Hz, and if the trim set point = 10 Hz, the speed reference would be 20 Hz + 5 Hz + 10 Hz = 35 Hz. If the trim percentage = -25% and the trim set point = -10 Hz, then the speed reference would = 5 Hz.

Min/Max Fwd/Rev Speed

Maximum and minimum speed limits are applied to the forward and reverse reference. The minimum speed limits will create a band that the drive will not run continuously within, but will ramp through. This is due to the forward or reverse minimum speeds, P522 [Min Fwd Speed] and P523 [Min Rev Speed] respectively. If the reference is positive and less than the Min Fwd Speed, it is set to the Min Fwd Speed minimum. If the reference is negative and greater than Min Rev Speed minimum, it is set to the Min Rev Speed minimum. If the minimum is not 0, hysteresis is applied at 0 to prevent bouncing between the Min Fwd Speed and Min Rev Speed minimums. If the reference is greater than the forward or reverse maximum speeds, P520 [Max Fwd Speed] and P521 [Max Rev Speed] respectively, the speed reference is clamped to the their respective maximum limit.

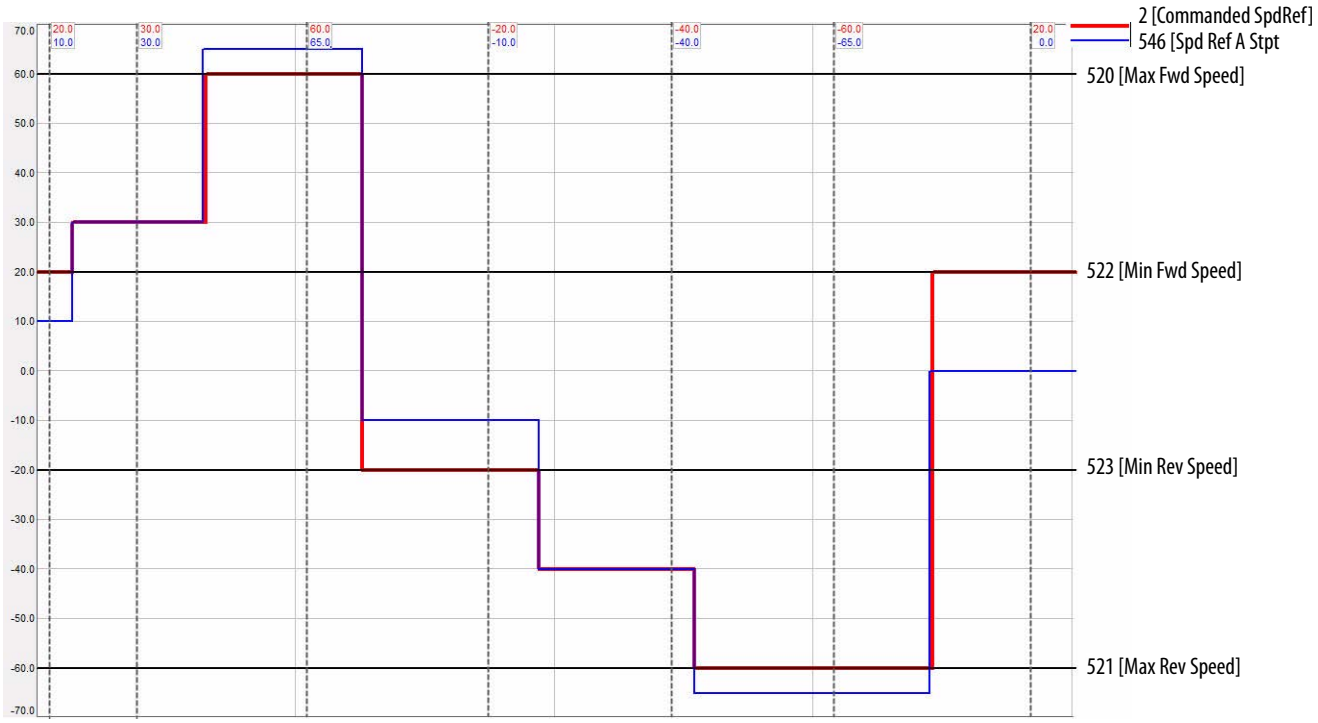


See example below:

- P520 [Max Fwd Speed] = 60 Hz
- P521 [Max Rev Speed] = -60 Hz
- P522 [Min Fwd Speed] = 20 Hz
- P523 [Min Rev Speed] = -20 Hz
- P545 [Spd Ref A Sel] = P546 [Spd Ref A Setpoint]

The picture below depicts how the Min/Max Fwd/Rev Speed bands and its influence the drive. The BLUE line depicts the desired speed reference (set point)

and the RED line depicts the drive's commanded speed reference (actual). Notice there are different results, depicted by the grey dotted line, along the graph.



Maximum Frequency

P37 [Maximum Freq] defines the maximum reference frequency. The actual output frequency may be greater as a result of slip compensation and other types of regulation.

Speed Regulation

A number of parameter are used to control speed regulation.

Overall Operation for Sensorless Vector Control and Volts per Hertz Control

The drive takes the speed reference and adjusts it using a proportional and integral regulator to compensate for slip and the programmed limits.

Overall Operation for Flux Vector Control

The drive takes the speed reference that is specified by the speed reference control loop and compares it to the speed feedback. The speed regulator uses proportional and integral gains along with other advanced tuning features to adjust the torque reference that is sent to the motor. The torque reference is used to operate the motor at the specified speed. The regulator is designed for optimal bandwidth for changing speed and load. If an alternate feedback device is used with automatic tachometer switchover, the alternate values of these parameters will be used.

Desired Speed Regulator Bandwidth - Speed Reg BW (P636)

The Speed Regulator Bandwidth sets the speed loop bandwidth and determines the dynamic behavior of the speed loop. As bandwidth increases, the speed loop becomes more responsive and can track a faster changing speed reference. A change to this parameter will cause an automatic update of P645 [Speed Reg Kp], P647 [Speed Reg Ki] and P644 [Spd Err Filt BW]. To disable the automatic gain and filter update, set this parameter to a value of zero. The configuration settings for Inertia Adaption (PowerFlex 755 only) will also be automatically selected when this feature is enabled.

The maximum allowable value of this parameter will be limited by the ratio of P646 [Spd Reg Max Kp] to P76 [Total Inertia], and the type of speed feedback source in use (encoder versus open loop). For operation following an automatic tach switchover, the bandwidth specified in P648 [Alt Speed Reg BW] will be used.

Total Inertia of Motor and Load - Total Inertia (P76)

The Total Inertia is the time in seconds for a motor coupled to its load to accelerate from zero to base speed at rated motor torque. This value is calculated during an Inertia Tune, after the motor has ramped up to speed and down and back down to zero speed. Adjusting this parameter will cause the drive to calculate and change the speed regulator gains.

Speed Loop Damping - Spd Loop Damping (P653)

Sets the damping factor of the vector speed loop's characteristic equation. Damping will affect the integral gain when a non-zero bandwidth has been entered. A damping factor of 1.0 is considered critical damping. Lowering the damping will produce faster load disturbance rejection, but may cause a more oscillatory response. When the speed regulator bandwidth is zero, gains are set manually and damping factor has no effect.

Integral Gain - Speed Reg Ki (P647)

Sets the integral gain of the speed regulator (in FV Motor Control modes). This value is automatically calculated based on the bandwidth setting in P636 [Speed Reg BW], P645 [Speed Reg Kp] and P653 [Spd Loop Damping]. Integral gain may be manually adjusted by setting P636 [Speed Reg BW] to a value of zero. Integral gain has effective scaling of (per unit torque/sec) / (per unit speed).

Proportional Gain - Speed Reg Kp (645)

This value is automatically calculated based on the bandwidth setting in P636 [Speed Reg BW] and P76 [Total Inertia]. The proportional gain may be manually adjusted by setting P636 [Speed Reg BW] to a value of zero. Proportional gain has effective scaling of (per unit torque) / (per unit speed). The maximum allowable value of this parameter is limited by P76 [Total Inertia] and P646 [Spd Reg Max Kp].

Feed Forward Gain - SpeedReg AntiBckup (P643)

Allows control of over-shoot/under-shoot in the step response of the Vector Control mode speed regulator. Over-shoot/under-shoot can be effectively eliminated with a setting of 0.3, which will remove backup of the motor shaft when zero speed is reached. This parameter has no affect on the drive's response to load changes. A value of zero disables this feature.

Servo Lock Gain - Servo Lock Gain (P642) (PowerFlex 755 only)

Sets the gain of an additional integrator in the Vector Control mode speed regulator. The effect of Servo Lock is to increase stiffness of the speed response to a load disturbance. It behaves like a position regulator with velocity feed forward, but without the pulse accuracy of a true position regulator. Gain should normally be set to less than 1/3 speed regulator bandwidth, or for the desired response. A value of zero disables this feature.

Speed Torque Position

The PowerFlex 750-Series drives have the ability to have four separate Speed Torque Position modes with the following parameters:

- P309 [SpdTrqPsn Mode A]
- P310 [SpdTrqPsn Mode B]
- P311 [SpdTrqPsn Mode C]
- P312 [SpdTrqPsn Mode D]

Possible selections for the above Speed/Torque/Position parameters are as follows:

- "Zero Torque" (0) – Drive operates as a torque regulator with P685 [Selected Trq Ref] forced to a constant value of zero torque.
- "Speed Reg" (1) – Drive operates as a speed regulator. P685 [Selected Trq Ref] comes from P660 [SReg Output] plus P699 [Inertia Comp Out].
- "Torque Ref" (2) – Drive operates as a torque regulator. P685 [Selected Trq Ref] comes from P4 [Commanded Trq]. Under some conditions such as jogging or performing a ramp to stop operation, the drive will automatically bypass this selection and temporarily switch to Speed Regulation mode.
- "SLAT Min" (3) – Drive operates in "Speed Limited Adjustable Torque – Minimum select" mode. This is a special mode of operation used primarily in web handling applications. The drive will typically operate as a torque regulator, provided that the P4 [Commanded Trq] value is algebraically smaller in value than the speed regulator's output. The drive may automatically enter Speed Regulation mode, based on conditions within the speed regulator and the magnitude of the speed regulator's output relative to the torque reference.
- "SLAT Max" (4) – Drive operates in "Speed Limited Adjustable Torque – Maximum select" mode. This is a special mode of operation used primarily in web handling applications. The drive will typically operate as a torque regulator, provided that the P4 [Commanded Trq] value is algebraically larger in value than the speed regulator's output. The drive may automatically enter Speed Regulation mode, based on conditions within the speed regulator and the magnitude of the speed regulator's output relative to the torque reference.
- "Sum" (5) – Drive operates as a speed regulator. P685 [Selected Trq Ref] comes from P660 [SReg Output] plus torque adders summed with P4 [Commanded Trq].
- "Profilier" (6) PowerFlex 755 – Drive uses the Speed Profiler / Position Indexer function. The drive operates as either a speed or position regulator. Mode of operation will depend on the configuration of the Step Types in the Profiler / Indexer table.
- "Psn PTP" (7) – Drive operates as a position regulator. P685 [Selected Trq Ref] has the same source as in Sum mode. The position control is active in Point-to-Point mode and uses its Point-to-point position reference.

- "Psn Camming" (8) PowerFlex 755 – Drive operates as a position regulator. P685 [Selected Trq Ref] has the same source as in Sum mode. The position control is active in Position CAM mode and uses its PCAM Planner position and speed reference.
- "Psn PLL" (9) PowerFlex 755 – Drive operates as a position regulator. P685 [Selected Trq Ref] has the same source as in Sum mode. The position control is active in Position Phase Lock Loop mode and uses its PLL Planner position and speed reference.
- "Psn Direct" (10) – Drive operates as a position regulator. P685 [Selected Trq Ref] has the same source as in Sum mode. The position control is active in Direct mode and uses its Direct Position Reference.
- "Psn SpdlOrnt" (11) PowerFlex 755 – Drive operates in the Positioning mode to position the load side of a machine to P1582 [SO Setpoint].

These modes selections only apply to the Flux Vector control modes in P35 [Motor Ctrl Mode], options 3 "Induction FV," 6 "PM FV," and 10 "IPM FV." These parameters select between speed regulation, torque regulation, or position regulation operation of the drive. The source of P685 [Selected Trq Ref] will be determined by the selection in these parameters when P181 [DI SpTqPs Sel 0] and P182 [DI SpTqPs Sel 1] have selected "Disabled" or selected bits that are logic low. In P935 [Drive Status 1], three bits are provided that indicate the Regulation mode of the drive when it is running. Bit 21 "Speed Mode" will become set when the drive is running with the speed regulator active. Similarly, Bit 22 "PositionMode" and Bit 23 "Torque Mode" indicate when their respective regulation modes are active. Under some conditions, the active Torque mode may be forced into Speed mode regardless of the setting of Speed/Torque/Position. P313 [Actv SpTqPs Mode] will indicate this and will reflect the mode selection that is in use.

Figure 23 - PowerFlex 753 Firmware Flowchart

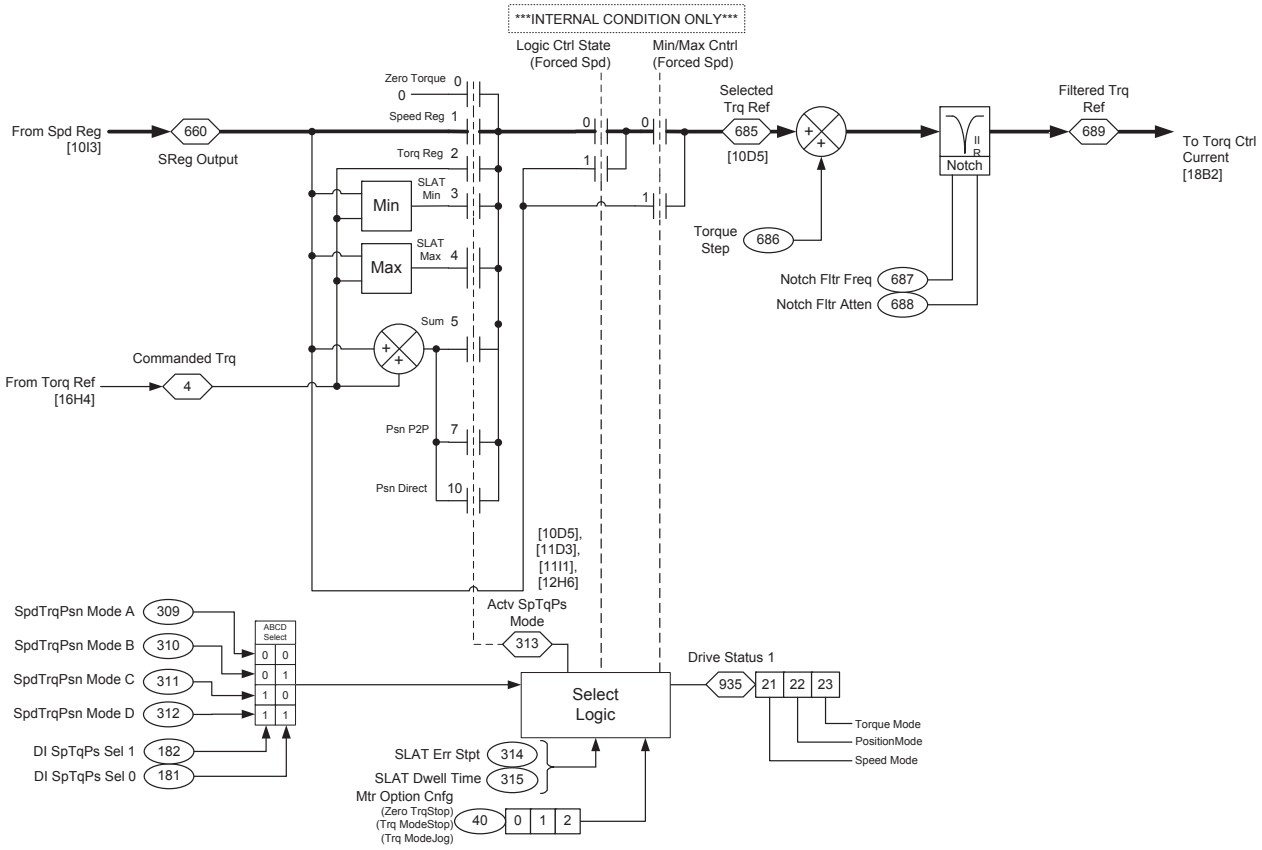
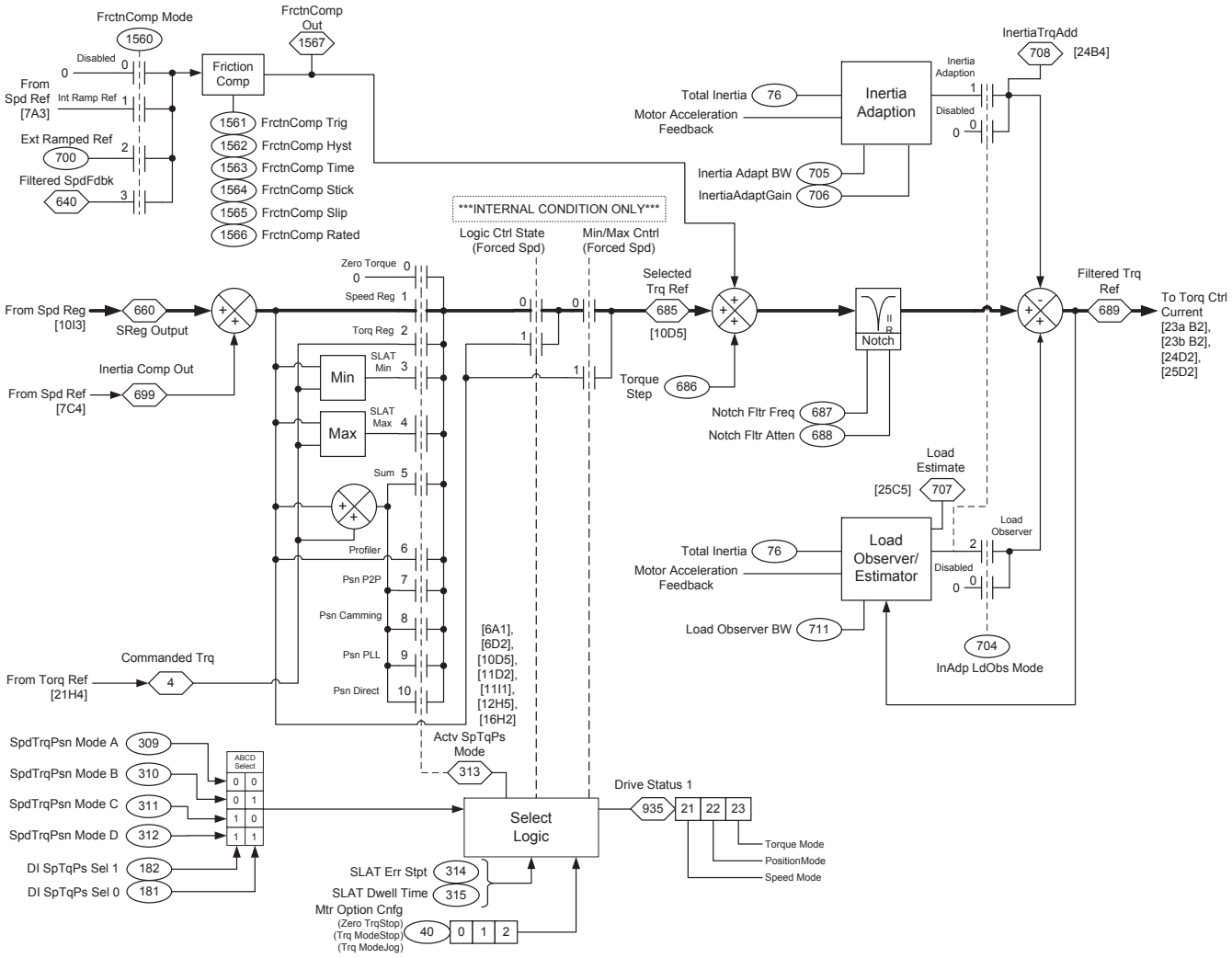


Figure 24 - PowerFlex 755 Firmware Flowchart



Speed Torque Position Modes

Zero Torque

Operation in Zero Torque mode allows the motor to be fully fluxed and ready to rotate when a speed command or torque command is given. This mode can be used for a cyclical application where throughput is a high priority. The control logic can select zero torque during the rest portion of a machine cycle instead of stopping the drive. When the cycle start occurs, instead of issuing a start to the drive, a Speed Regulator mode can be selected. The drive will then immediately accelerate the motor without the need for flux up time.

IMPORTANT Zero Torque may excessively heat the motor if operated in this mode for extended periods of time. A load or flux current is still present when the drive is operating in Zero Torque mode. A motor with an extended speed range or separate cooling methods (blower) may be required.

Speed Regulation

Operating as a speed regulator is the most common and simplest mode to set up. Examples of speed regulated applications are blowers, conveyors, feeders, pumps, saws, and tools. In a speed regulated application, the speed regulator output generates the torque reference. Note that under steady state conditions the speed feedback is steady while the torque reference is a constantly adjusting signal. This is required to maintain the desired speed. In a transient state, the torque reference changes dramatically to compensate for a speed change. A short duration change in speed is the result of increasing or decreasing the load very rapidly.

For the PowerFlex 755 drive, the Inertia Compensation, Inertia Adaption, and the Friction Compensation influence the output of the speed regulator.

Torque Regulation

A torque regulated application can be described as any process requiring some tension control. An example is a winder or unwinder with material being drawn or pulled with a specific tension required. The process also requires that another element set the speed. Configuring the drive for torque regulation requires P309 [SpdTrqPsn Mode A] to be set to 2 "Torque Ref." In addition, a reference signal must be linked to the torque reference. For example, when Analog Input 0 is used for the torque reference, P675 [Trq Ref A Sel] will need to be configured for "Anlg In0 Value."

When operating in a Torque mode, the motor current will be adjusted to achieve the desired torque. If the material being wound or unwound breaks, the load will decrease dramatically and the motor can potentially go into a runaway condition. Speed Limited Adjustable Torque (SLAT) Min and SLAT Max The SLAT minimum and SLAT Maximum modes are for applications that require a smooth transition from a Torque mode to a Speed mode operation; for example: web handling, center winders and center unwinders where the drive is normally following a torque reference, but a break or slippage could occur. Direction of the applied torque and direction of the material movement determine whether SLAT minimum or SLAT Maximum mode should be used.

SLAT Min

In SLAT Minimum mode, you would typically configure a speed reference that forces the speed regulator into saturation (the speed reference is slightly above the speed feedback). In this case the drive would follow the torque reference until there was a breakage or slippage in the application.

When the drive is following a torque reference (Torque mode) in SLAT Minimum mode, either one of two conditions will force the drive into following the speed reference (Speed mode):

- The output of the speed regulator becomes less than the torque reference. This is the same condition that exists in Minimum Torque mode.

  Or

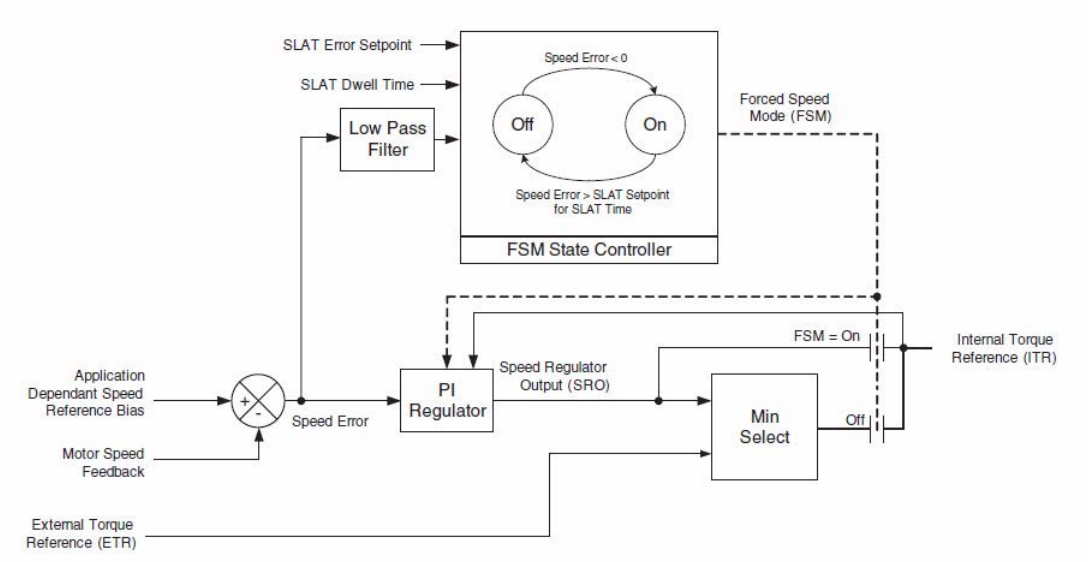
- The speed error becomes negative (the speed feedback becomes greater than the speed reference). This is Forced Speed mode. By forcing the drive to enter Speed mode, the transition occurs earlier than it would have in the Minimum Torque mode, resulting in less velocity overshoot.

P314 [SLAT Err Stpt] and P315 [SLAT Dwell Time] let you to set some hysteresis for turning off the Forced Speed mode. They are set to 0 as default so that there is no hysteresis. In SLAT Minimum mode, [SLAT Err Stpt] sets how much less the speed feedback should be than the speed reference before turning off the Forced Speed mode. The [SLAT Dwell Time] sets how long the speed error must exceed the SLAT error set point before turning off the Forced Speed mode.

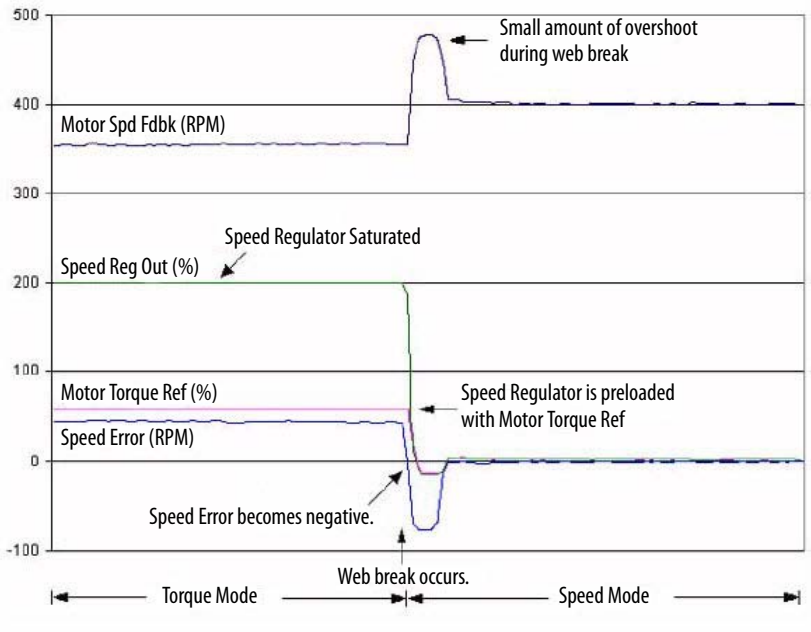
At the time that the drive switches from Torque mode to Forced Speed mode, the speed regulator output is loaded with the internal motor torque reference to create a smooth transition.

In order for the drive to switch from Speed mode to Torque mode, Forced Speed mode (if active) must first be turned off. Forced Speed mode will turn off when the speed error is greater than the SLAT error set point for the SLAT dwell time. With default parameter settings, this will occur when the speed error becomes positive.

When Forced Speed mode is off, the drive will switch back to Torque mode when the speed regulator output becomes greater than the torque reference. This is the same condition that exists in Minimum Torque mode.



Paper Winder Application Example:
The drive is set for SLAT Minimum mode, so that the drive normally runs in Torque mode and follows P675 [Trq Ref A Sel]. [Trq Ref A Sel] is coming from an external controller and is approximately 60% of motor torque during the snapshot (shown below). The speed reference, also from an external controller, is set just above the speed feedback to saturate the speed regulator while in Torque mode. The following snapshot captures what occurs in the drive during a break in the web.



SLAT Max

In SLAT Maximum mode, you would typically configure a speed reference that forces the speed regulator into saturation (the speed reference is slightly below the speed feedback). In this case the drive would follow the torque reference until there was a breakage or slippage in the application.

In SLAT Maximum mode, the drive will switch from Torque mode to Speed mode when either one of the two following conditions occur:

The output of the speed regulator becomes more than the torque reference. This is the same condition that exists in Maximum Torque mode.

Or

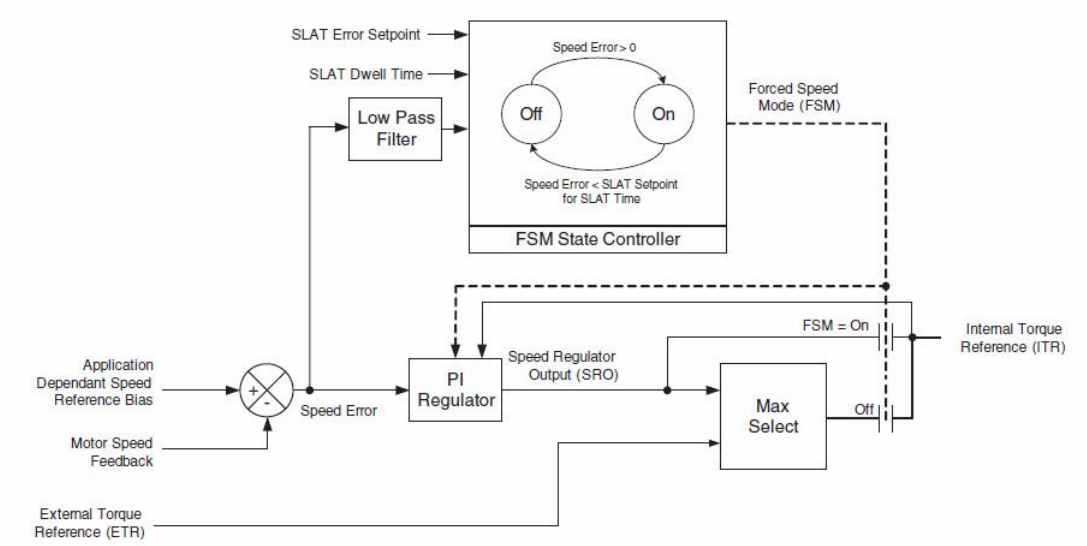
The speed error becomes positive (the speed feedback becomes less than the speed reference). This is Forced Speed mode. By forcing the drive to enter Speed mode, the transition occurs earlier than it would have in the Maximum Torque mode, resulting in less velocity overshoot.

P314 [SLAT Err Stpt] and P315 [SLAT Dwell Time] lets you set some hysteresis for turning off the Forced Speed mode. They are set to 0 as default so that there is no hysteresis. In SLAT Maximum mode, [SLAT Err Stpt] sets how much more the speed feedback should be than the speed reference before turning off the Forced Speed mode. The [SLAT Dwell Time] sets how long the speed error must be less than the SLAT error set point before turning off the Forced Speed mode.

At the time that the drive switches from Torque mode to Speed mode, the speed regulator output is loaded with the value from the torque reference to create a smooth transition.

In order for the drive to switch from Speed mode to Torque mode, Forced Speed mode (if active) must first be turned off. Forced Speed mode will turn off when the speed error is less than the SLAT error set point for the SLAT dwell time. With default parameter settings, this will occur when the speed error becomes negative.

When Forced Speed mode is off, the drive will switch back to Torque mode when the speed regulator output becomes less than the torque reference. This is the same condition that exists in Maximum Torque mode.



Sum

Configuring the drive in this mode allows an external torque input to be summed with the torque command generated by the speed regulator. This mode requires both a speed reference and a torque reference. This mode can be used for applications that have precise speed changes with critical time constraints. If the torque requirement and timing is known for a given speed change, then the external torque input can be used to preload the integrator. The timing of the speed change and the application of an external torque command change must be coordinated for this mode to be useful. The Sum mode will then work as a feed forward to the torque regulator.

Drive Features

Data Logging

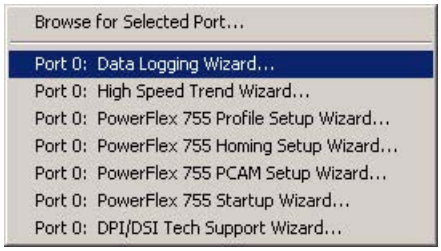
This wizard will log the values of up to six parameters in a single drive at a specified interval for some period of time, with the minimum sample rate one second. The information is saved as a comma delimited *.csv file for use with Microsoft Excel or any other spreadsheet program. Clicking Next lets you configure the data logger. When data logging is completed, click Finish to close the wizard. If you click Finish before the data logging is completed, only the data collected up to that point will be saved in the file. You can cancel the wizard at any time by clicking Cancel or the Close icon. All logged data will be lost, and the file will be deleted.

Configuration Example

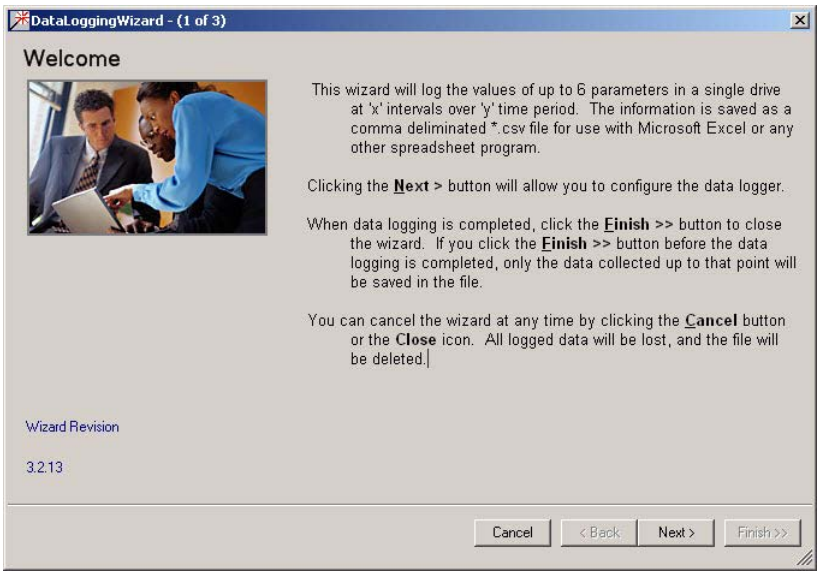
1. Connect to the drive that you want to trend via DriveExecutive, DriveExplorer, RSLogix 5000 Drive AOPs or Connected Components Workbench software tool.

2. Click the Show Wizard icon .

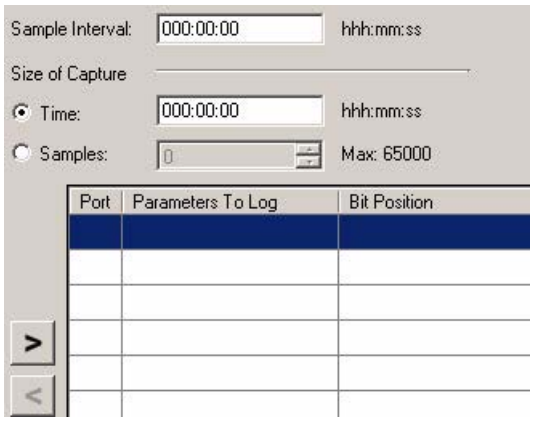
   Depending if you click the wand icon or down arrow icon a particular wizard selection dialog box will appear. Select the Data Logging Wizard.


Browse for Selected Port...
Port 0: Data Logging Wizard...
Port 0: High Speed Trend Wizard...
Port 0: PowerFlex 755 Profile Setup Wizard...
Port 0: PowerFlex 755 Homing Setup Wizard...
Port 0: PowerFlex 755 PCAM Setup Wizard...
Port 0: PowerFlex 755 Startup Wizard...
Port 0: DPI/DSI Tech Support Wizard...

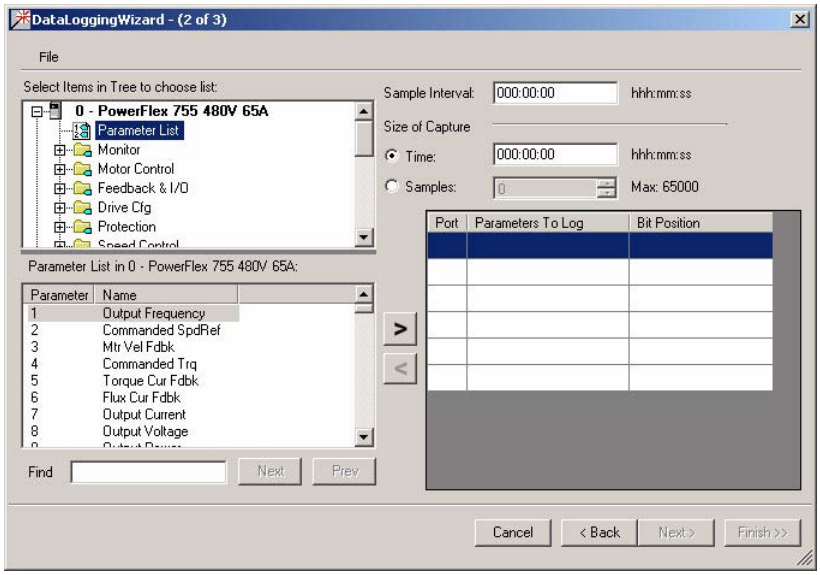
3. Once the Welcome screen loads, click Next.


DataLoggingWizard - (1 of 3)
Welcome
This wizard will log the values of up to 6 parameters in a single drive at 'x' intervals over 'y' time period. The information is saved as a comma deliminated *.csv file for use with Microsoft Excel or any other spreadsheet program.
Clicking the Next > button will allow you to configure the data logger.
When data logging is completed, click the Finish >> button to close the wizard. If you click the Finish >> button before the data logging is completed, only the data collected up to that point will be saved in the file.
You can cancel the wizard at any time by clicking the Cancel button or the Close icon. All logged data will be lost, and the file will be deleted.
Wizard Revision
3.2.13
Cancel
< Back
Next >
Finish >>

The data logging wizard can be configured to log up to six parameters at a minimum sample rate of one second for a specified time or number of samples.



4. To find a parameter that you want to log, select the Port, and then scroll through the parameter lists, file folders, diagnostic items or use the find function.



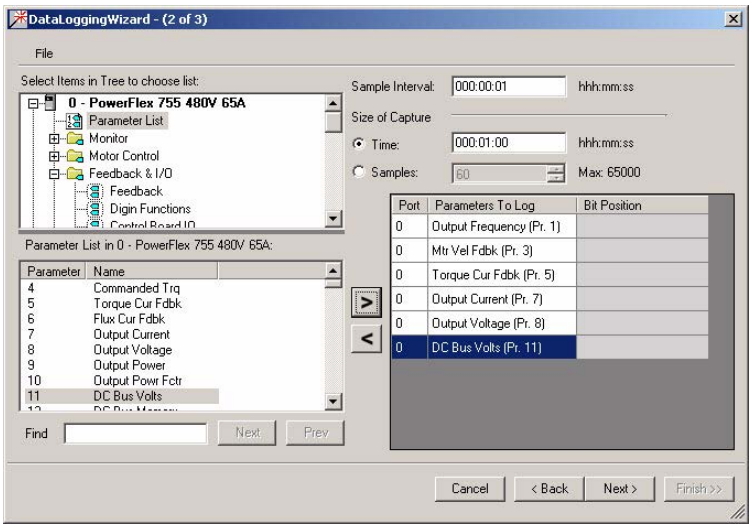
5. To add the parameter to the data log list, select the parameter on the left-side list and click the right arrow .

   You will see that parameter appear in the first available line entry on the right side.

6. To remove a parameter from the data log list, select the parameter on the right side and click the left arrow .

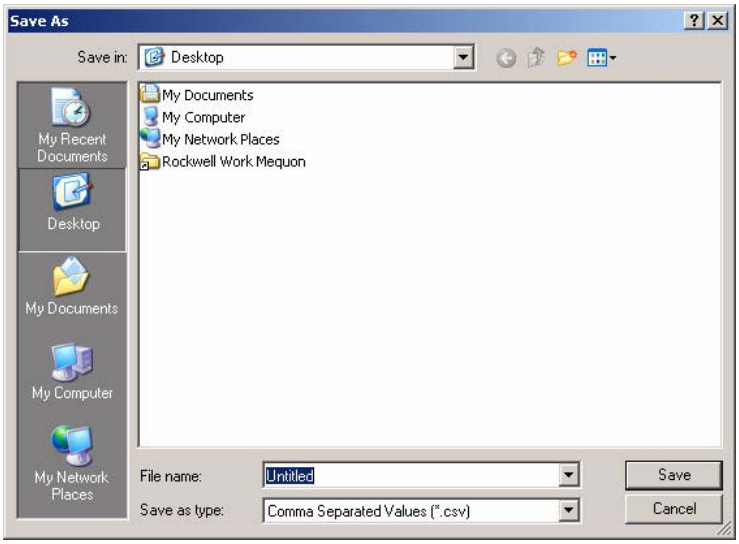
   You will see that parameter disappear from that line entry and all subsequent entries will move up.

In the configuration example below, the data logging wizard is configured to log six drive parameters consisting of Output Frequency, Motor Velocity Feedback, Torque Current Feedback, Output Current, Output Voltage, and DC Bus Voltage parameter values.



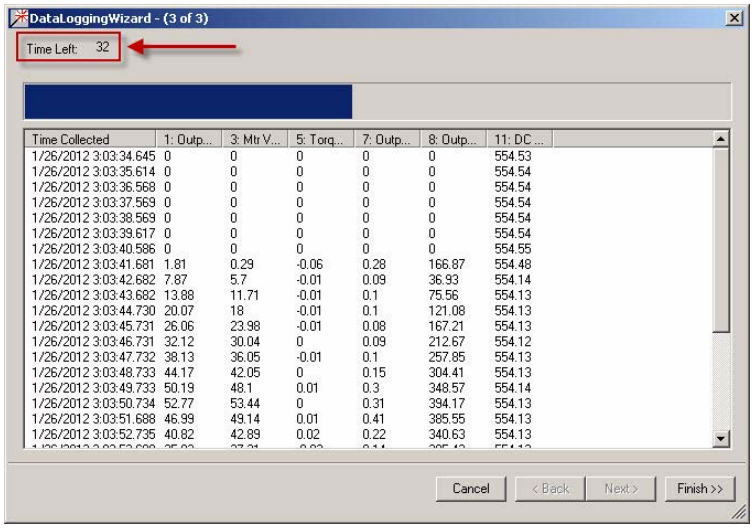
7. Click Next.

This will prompt a save as dialog box that will save the data log information as a comma delimited *.csv file for use with Microsoft Excel or any other spreadsheet program.

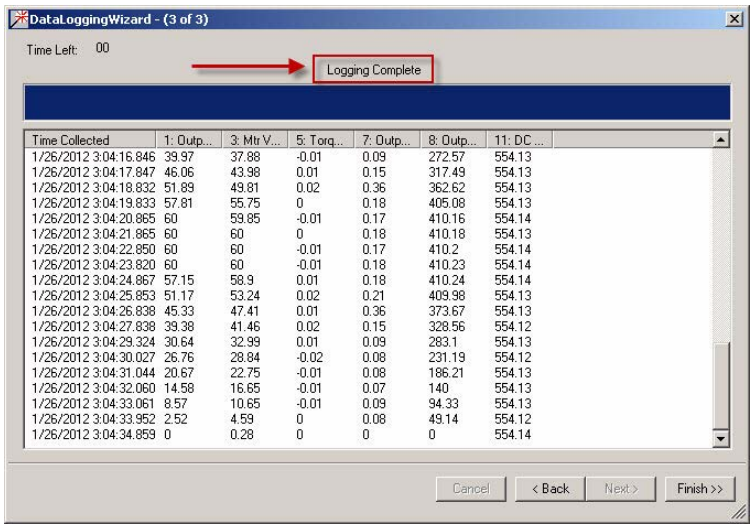


8. To start the data logging, click Save.

   As the data logging begins, you will see a Time Left timer counting down as well as a blue progress bar moving to right.



When the data logging has finished, a Logging Complete message will be displayed.



Each column's width is adjustable.

Below is a spreadsheet example of data logged. Use a spreadsheet program to open the *.csv file.

	A	B	C	D	E	F	G	H	I	J	K
1	Date	Time	Millisecond Part	Ellapsed Milliseconds	Time Label	1: Output Frequency	3: Mtr Vel Fdbk	5: Torque Cur Fdbk	7: Output Current	8: Output Voltage	11: DC Bus Volts
2	26-Jan-12	3:03:34 PM	645	641	03:34.6	0	0	0	0	0	554.53
3	26-Jan-12	3:03:35 PM	614	1610	03:35.6	0	0	0	0	0	554.54
4	26-Jan-12	3:03:36 PM	568	2564	03:36.6	0	0	0	0	0	554.54
5	26-Jan-12	3:03:37 PM	569	3565	03:37.6	0	0	0	0	0	554.54
6	26-Jan-12	3:03:38 PM	569	4565	03:38.6	0	0	0	0	0	554.54
7	26-Jan-12	3:03:39 PM	617	5613	03:39.6	0	0	0	0	0	554.54
8	26-Jan-12	3:03:40 PM	586	6582	03:40.6	0	0	0	0	0	554.55
9	26-Jan-12	3:03:41 PM	681	7677	03:41.7	1.81	0.29	-0.06	0.28	166.87	554.48
10	26-Jan-12	3:03:42 PM	682	8677	03:42.7	7.87	5.7	-0.01	0.09	36.93	554.14
11	26-Jan-12	3:03:43 PM	682	9678	03:43.7	13.88	11.71	-0.01	0.1	75.56	554.13
12	26-Jan-12	3:03:44 PM	730	10726	03:44.7	20.07	18	-0.01	0.1	121.08	554.13
13	26-Jan-12	3:03:45 PM	731	11727	03:45.7	26.06	23.98	-0.01	0.08	167.21	554.13

Energy Savings

Setting the motor control mode P35[Motor Ctrl Mode] to Induct Econ (2) or Induction Economizer mode will enable additional energy savings within the drive. To be specific, additional energy savings can be realized in constant torque applications that have constant speed reduced load periods.

Induction Economizer

Induction Economizer mode consists of the sensorless vector control with an additional energy savings function. When steady state speed is achieved, the economizer becomes active and automatically adjusts the drive output voltage based on applied load. By matching output voltage to applied load, the motor efficiency is optimized. Reduced load commands a reduction in motor flux current.

To optimize the performance of the Induction Economizer mode, adjust the following parameters:

- P47 [Econ At Ref Ki] - Integral gain that determines the response of the output voltage when the output frequency is at reference.
- P48 [Econ At AccDec Ki] - Integral gain that determines the response of the output voltage when the output frequency is accelerating or decelerating to the reference setpoint.
- P49 [Econ At AccDec Kp] - Proportional gain that determines the response of the output voltage when the output frequency is accelerating or decelerating to the reference setpoint.

High Speed Trending

The high speed trending wizard will configure the internal trending of the drive, download that trend configuration to the drive and will upload the trended data from the drive when finished. This information is saved as a comma delimited *.csv file for use with Microsoft Excel or any other spreadsheet program.

The high speed trending can be configured to trend up to eight parameters with 4096 samples for each parameter, at a minimum sample rate of 1.024 milliseconds. It can also be configured to trend up to four parameters with 1024 samples for each parameter, at a minimum sample rate of 256 microseconds. These are defined by the drive. Future drives may offer different options.

The PowerFlex 755 drives have the High Speed Trending functionality. PowerFlex 753 drives do not have the High Speed Trending functionality.

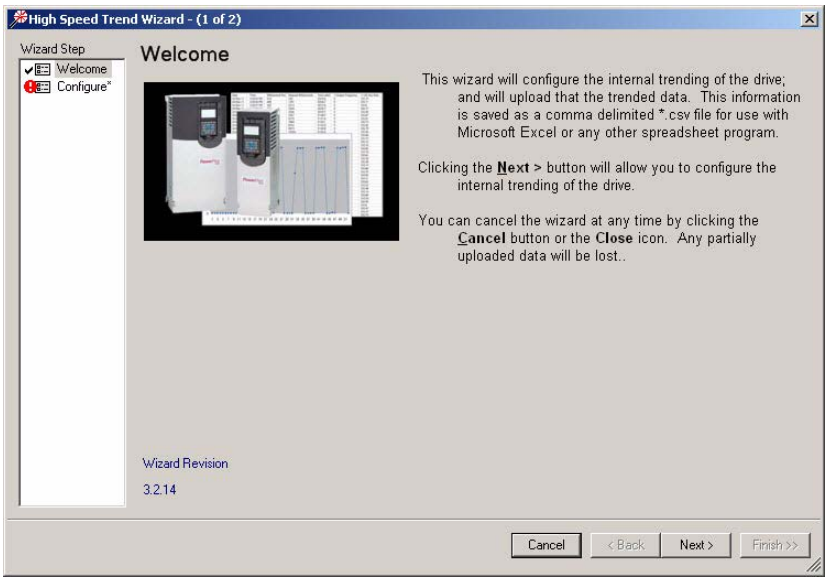
You can run only one wizard at a time.

Configuration Example

1. Connect to the drive that you want to trend via DriveExecutive, DriveExplorer, RSLogix 5000 Drive AOPs or Connected Components Workbench software tool.
2. Click the Show Wizard icon .

   Depending if you click the wand icon or down arrow icon a particular wizard selection dialog box will appear.
3. Select the High Speed Trend Wizard.

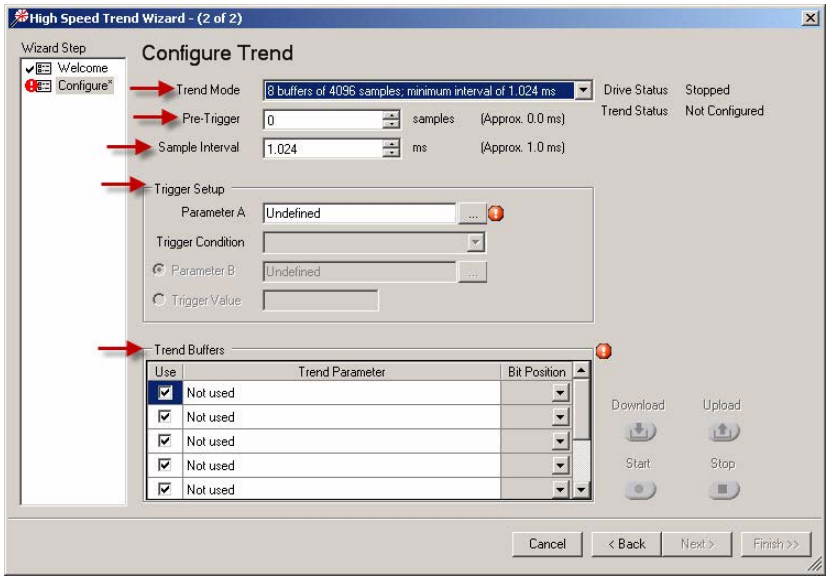
4. Once the Welcome screen loads, Click Next.


High Speed Trend Wizard - (1 of 2)
Wizard Step
Welcome
Configure*
Welcome
This wizard will configure the internal trending of the drive; and will upload that the trended data. This information is saved as a comma delimited *.csv file for use with Microsoft Excel or any other spreadsheet program.
Clicking the Next > button will allow you to configure the internal trending of the drive.
You can cancel the wizard at any time by clicking the Cancel button or the Close icon. Any partially uploaded data will be lost..
Wizard Revision
3.2.14
Cancel
< Back
Next >
Finish >>

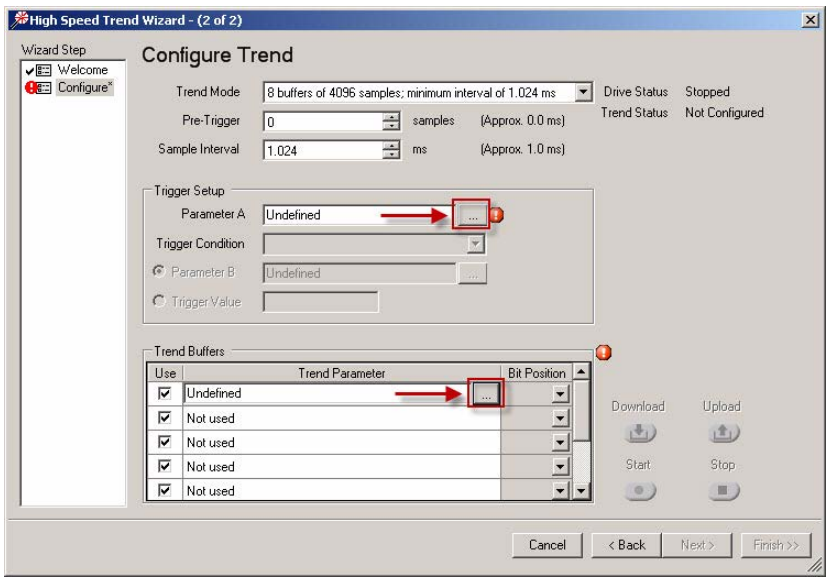
The Configure Trend window lets you customize the following high speed trend details:

- Trend Mode – dictates number of trend buffers, total number of samples, and the minimum interval sample rate.
- Pre-Trigger samples – dictates number of samples to include in the trend before the trigger.
- Sample Interval – the time interval between trend data samples.
- Trigger Setup – dictates how the data trend is triggered
  a. Comparing two parameters
  b. Comparing a parameter against a constant
  c. A test bit in a parameter

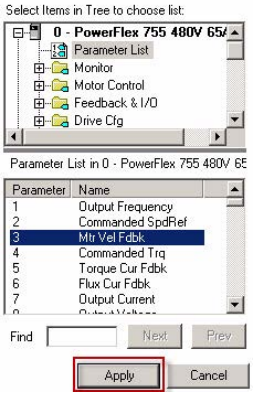
- Trend Buffers – dictates the drive and/or peripheral parameters and diagnostic items that will be trended.



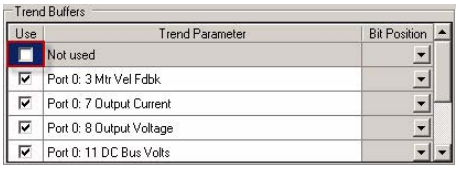
5. To configure the Trigger Setup and Trend Buffers, click the Ellipse button ... .



6. Select the parameter that you want to log by selecting the Port, and then scroll through the parameter lists, file folders, diagnostic items or use the find function and click Apply.



The best way to remove a parameter selection is to uncheck the check box in the Use column.



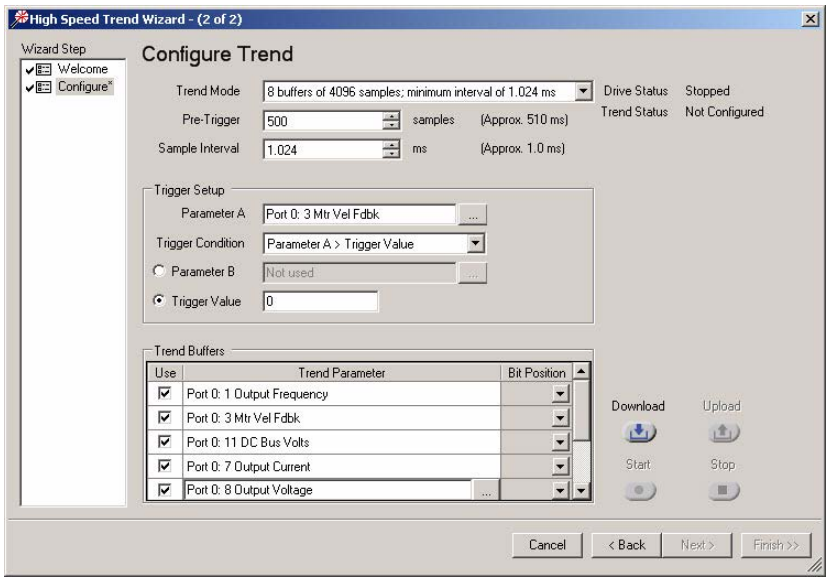
"Not used" will be downloaded instead of the selected parameter. The next time that you launch the wizard, that buffer will have no parameter set.

In the example below, the trend buffers are configured with five drive parameters consisting of Output Frequency, Motor Velocity Feedback, DC Bus Voltage, Output Current, Output Voltage parameter values. The trend is configured for a total of 4096 samples that will include 500 samples before the trigger, at a sample rate of 1.024 ms. The trigger of the high speed trend will be the Motor Velocity Feedback greater than zero.

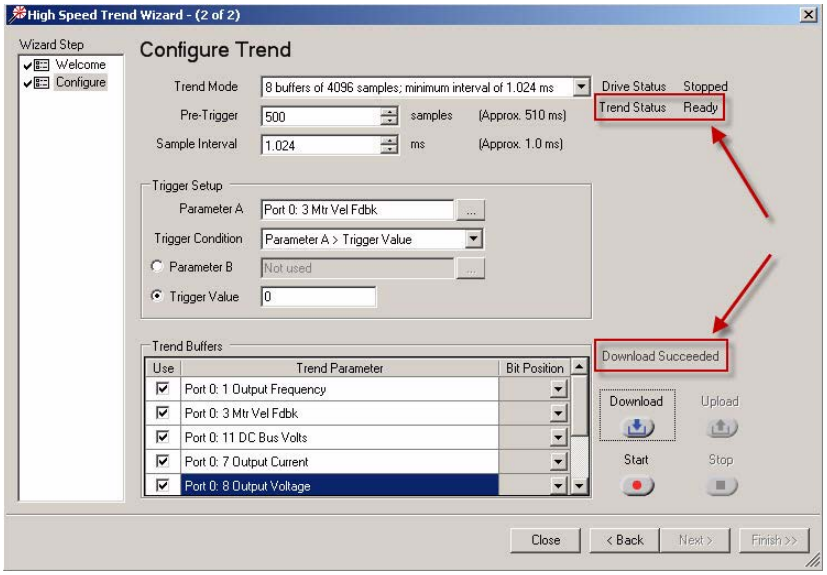
This means the following:

- The drive will start trending.
- When the motor starts rotating forward, the trend will start wrapping up.
- The drive will continue trending for about 3.7 seconds to use up the remaining 3596 samples.

- The drive will stop trending and be ready for uploading.



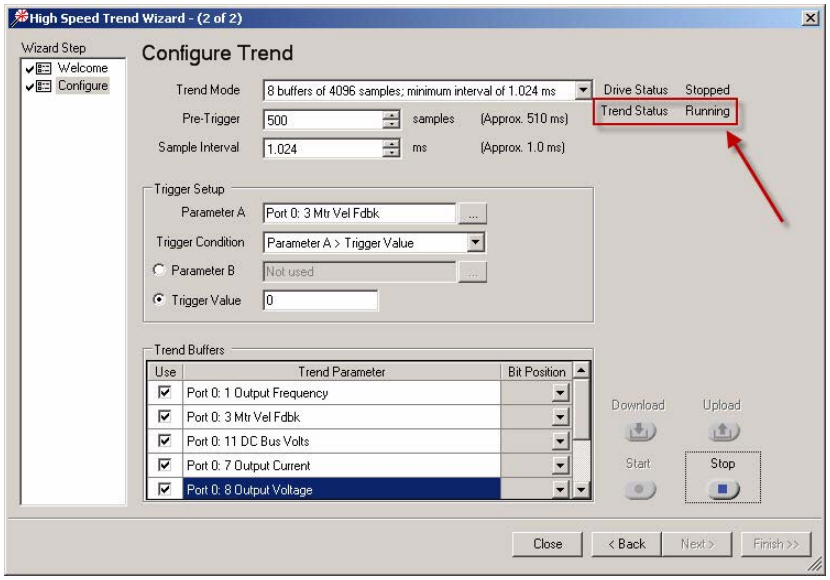
7. Click Download once the Download Succeeded message has appeared and the Trend Status is Ready.



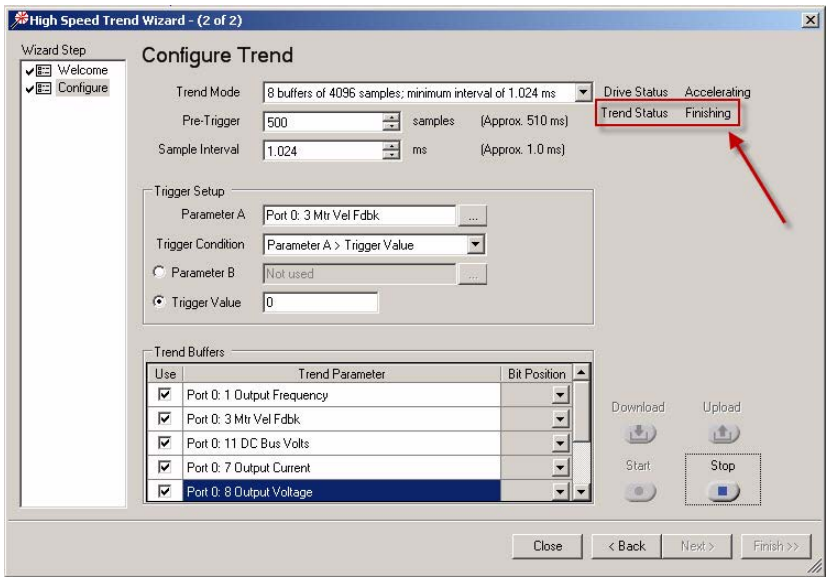
8. Click Start

.

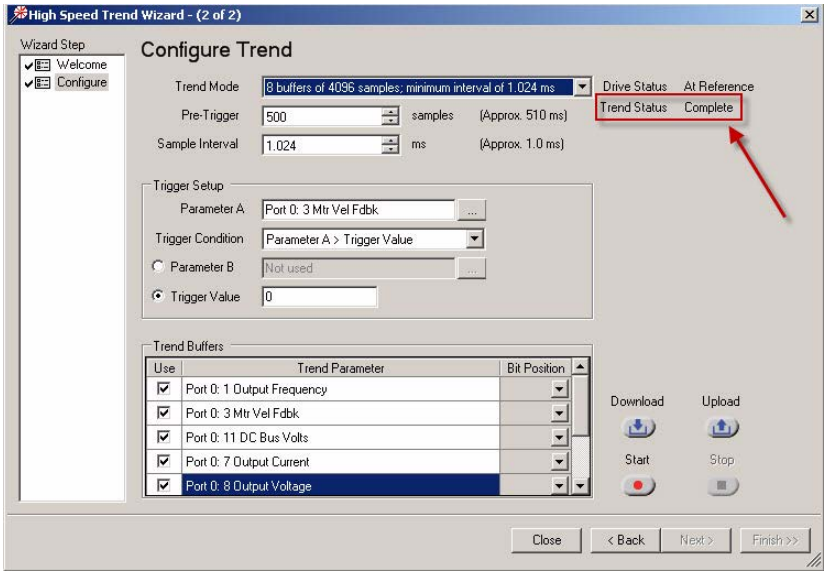
The Trend Status is Running and Download, Upload and Start buttons are unavailable.



The trending is in process when you see the Trend Status is in the Finishing state. You can stop the trend at any point in time by clicking Stop. You can then upload all of the data gathered so far.

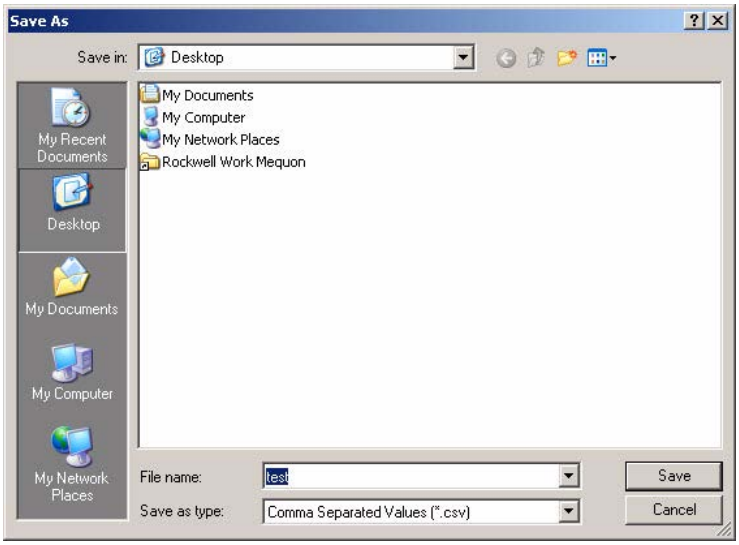


The trending has ended when the Trend Status has changed from Finishing state to the Complete state.

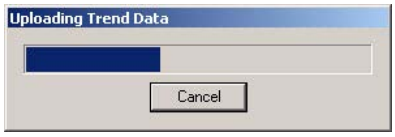


Click Upload

. This will prompt a process that will upload the trend data from the drive and save the information as a comma delimited *.csv file for use with Microsoft Excel or any other spreadsheet program.



Click Save to start the upload trend data process.

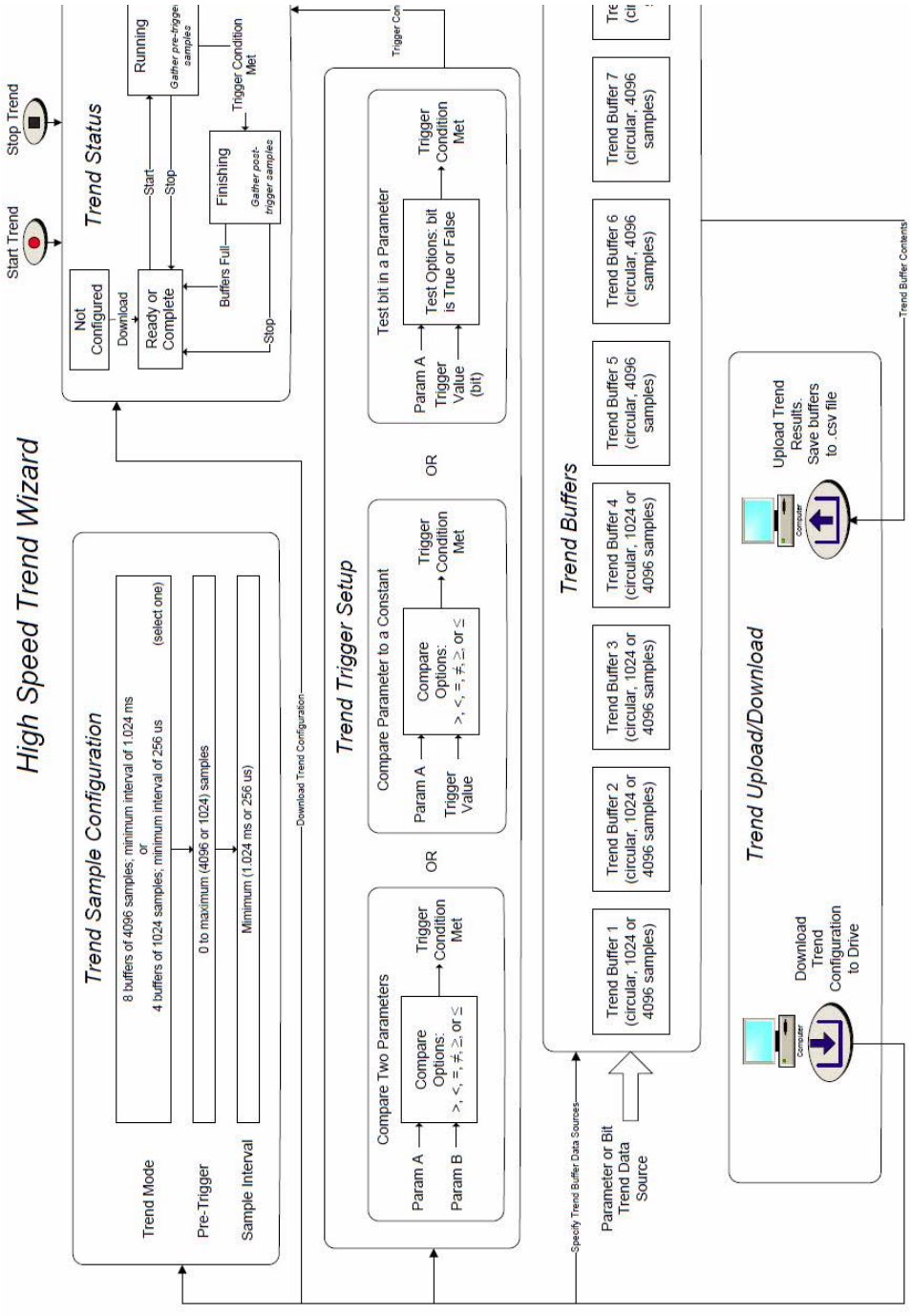


Below is an example of trended data. Use a spreadsheet program to open the *.csv file.

	A	B	C	D	E	F
1	Trigger Time	1/6/1970 21:03:02.493990592				
2						
3	Sample #	Time From Trigger (ms)	Port 0: 1 Output Frequency	Port 0: 1 Output Frequency - Internal Value	Port 0: 3 Mtr Vel Fdbk	Port 0: 3 Mtr Vel Fdbk - Internal Value
502	499	-2.048	0.18	0.1844133	0	0
503	500	-1.024	0.2	0.1967048	0	0
504	501	0	0.21	0.2090035	0.01	0.006590744
505	502	1.024	0.22	0.221308	0.01	0.006590744
506	503	2.048	0.23	0.2336136	0.01	0.008272989
507	504	3.072	0.25	0.2458963	0.01	0.008272989
508	505	4.096	0.26	0.258179	0.01	0.01014278
509	506	5.12	0.27	0.2704785	0.01	0.01014278
510	507	6.144	0.28	0.2827779	0.01	0.01219858
511	508	7.168	0.3	0.2950927	0.01	0.01219858
512	509	8.192	0.31	0.3074133	0.01	0.01443886
513	510	9.216	0.32	0.3197084	0.01	0.01443886
514	511	10.24	0.33	0.3319962	0.02	0.01686212

Column C here lines up with what you would see in DriveExplorer or any other drive software tool. Column D shows the value that the drive is using internally. Column D has more accurate data, but you will probably not have a use for the extra precision. You cannot get the data in column D from any other wizard or software tool.

Block Diagram



Position Homing

The Homing function is a standalone function of the drive that moves the motor to a home position defined by a switch that is connected to a homing input on a feedback option module, digital input resident on the Main Control Board, or on an I/O option module if there is no feedback module. This function is typically run only once after the drive is powered up or if the drive has become lost. If a universal feedback option module is used, the homing input is part of the general Registration hardware. To perform the homing sequences that require this module, the drive will have to configure the Registration function on the module itself.

If a Position Absolute move is made, it is necessary to have performed either a Find Home or a Position Redefine procedure at some time after drive powerup. Until this is done, Bit 19 "Home Not Set" in [Profile Status] will remain set, preventing the profile from executing.

The Find Home state is entered from the Initialize Step state when the profile is enabled with the Find Home bit set in the Profile Command parameter. The drive will perform a procedure to establish the home position. The procedure consists of a move in Speed mode at the specified Find Home Speed. A digital input is used to sense when the home position limit switch has been traversed. If there is an encoder, the registration logic is used to latch the motor position when the limit switch is reached as the home position. The Find Home function will handle three possible cases; Switch and Marker, Switch only, and Marker only.

Homing Input Selection

With Feedback Device
Both the universal feedback option modules and the encoder feedback option modules provide a dedicated homing input. The homing input on the feedback module that is selected by P135[Mtr Pos Fdbk Sel] is used for homing. If the marker pulse from an encoder is used in the homing function it is also selected by P135[Mtr Pos Fdbk Sel].

Without Feedback Device
If the drive does not have a feedback module and a selection in P135[Mtr Psn Fdbk Sel] of "simulator feedback" is made the homing input that the drive uses is selected from any digital inputs residing on an attached I/O module by P734[DI OL Home Limit]. There would be no marker pulse input associated with "open loop" homing.

Homing Activation

A homing function can be selected by either a digital input or a parameter. The digital input is selected from any digital inputs residing on an attached I/O module by [Find Home Sel] or [Return Home Sel]. To select the homing function from a parameter set Bit 0 "Find Home" or Bit 3 "Return Home" of [Homing Control Cnfg] parameter. The homing sequence can be selected regardless of the mode selected in P313[Actv SpTqPs Mode]. If the drive has a feedback option module, a vector type control must be selected in [Motor Cntl Mode] parameter. If there is no feedback option module, any type of control can be selected.

When the Find Home function is selected by either a digital input or a parameter, either Bit 1 "Home Switch" or Bit 2 "Home Maker" or both must be selected in [Homing Control Cnfg] parameter.

When the Return Home function is selected by either a digital input or a parameter, a selection of Bit 1 "Home Switch" or Bit 2 "Home Maker" of [Homing Control Cnfg] parameter will be ignore.

To activate a Homing function, a drive start command is required if the drive is stopped. If a drive is running, the drive must be "At Zero Speed" state when the function is selected.

Drive Stopped During Activation
If the drive is stopped, a start command to drive is required to activate a homing sequence.

Drive Started and "At Zero Speed" During Activation
If the drive has already started and "At Zero Speed" the rising edge or toggled bit will activate and latch the homing sequence.

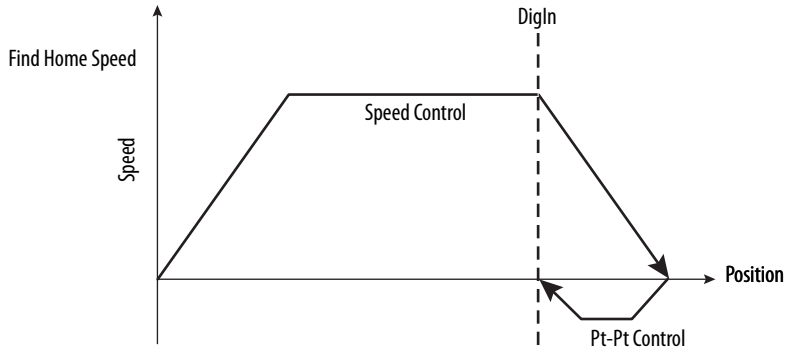
Drive Started and not "At Zero Speed" During Activation
If the drive has already started and not "At Zero Speed" the rising edge will be ignored and the homing sequence will not start.

Homing to Limit Switch with Feedback

Upon activation of homing the drive will start moving in Speed Control mode, and ramp to the speed and direction set in P735[Find Home Speed] at the rate set in P736[Find Home Ramp]. When the limit/proximity switch is reached the "Homing Input" is set. The position count is latched and is considered the home position count. The drive will then ramp to zero at the rate set in P736[Find Home Ramp]. The drive will then perform a "point to point" position move back to the home position count in speed of 1/10 of P735[Find Home Speed]. When the motor is "At Position" and "At Zero Speed, the homing sequence will complete.

NOT Hold At Home, P731 Bit 7
If a position control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running, holding position and transferring position reference back to its previous source. If velocity control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running holding zero velocity and transferring velocity reference back to its previous source.

Hold At Home, P731 Bit 7
If a position control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running, holding position; drive will then transfer position reference back to its previous source once it receives a start command. If velocity control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running holding zero velocity; drive will then transfer velocity reference back to its previous source once it receives a start command.

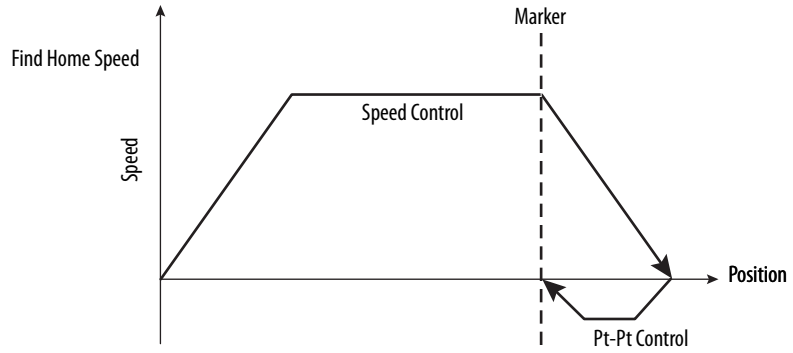


Homing to Marker Pulse with Feedback Upon activation of homing the drive will start moving in Speed Control mode, and ramp to the speed and direction set in P735[Find Home Speed] at the rate set in P736[Find Home Ramp]. When the Marker Pulse input is set the position count is latched and is considered the home position count after the marker pulse is reached, the drive will then ramp to zero in P736[Find Home Ramp]. The drive will then perform a "point to point" position move back to the home position count in speed of 1/10 of P735[Find Home Speed]. When the motor is "At Position" and "At Zero Speed," the homing sequence will complete.

NOT Hold At Home, P731 Bit 7
If a position control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running, holding position and transferring position reference back to its previous source. If velocity control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running holding zero velocity and transferring velocity reference back to its previous source.

Hold At Home, P731 Bit 7
If a position control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running, holding position; drive will then transfer position reference back to its previous source once it receives a start command. If velocity control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue

running holding zero velocity; drive will then transfer velocity reference back to its previous source once it receives a start command.



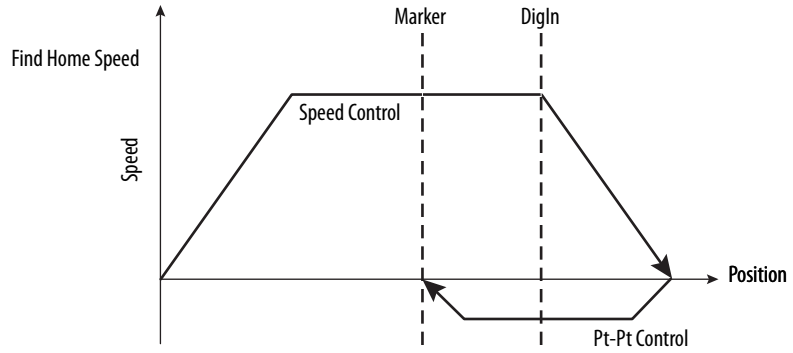
Homing to Switch and Marker Pulse with Feedback

Upon activation of homing the drive will start moving in Speed Control mode, and ramp to the speed and direction set in P735[Find Home Speed] at the rate set in P736[Find Home Ramp]. As the motor moves toward the limit/proximity switch, the marker pulse is triggering a register on the feedback module to latch the current position count. When the limit/proximity switch is reached the "Homing Input" is set. The last maker pulse position count that was latched prior to the "Homing Input" being set is considered the home position count. The drive will then ramp to zero at the rate set in P736[Find Home Ramp]. The drive will then perform a "point to point" position move back to the home position count in speed of 1/10 of P735[Find Home Speed]. When the motor is "At Position" and "At Zero Speed, the homing sequence will complete.

NOT Hold At Home, P731 Bit 7
If a position control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running, holding position and transferring position reference back to its previous source. If velocity control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running holding zero velocity and transferring velocity reference back to its previous source.

Hold At Home, P731 Bit 7
If a position control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running, holding position; drive will then transfer position reference back to its previous source once it receives a start command. If velocity control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue

running holding zero velocity; drive will then transfer velocity reference back to its previous source once it receives a start command.



Find Home DI without Feedback Device

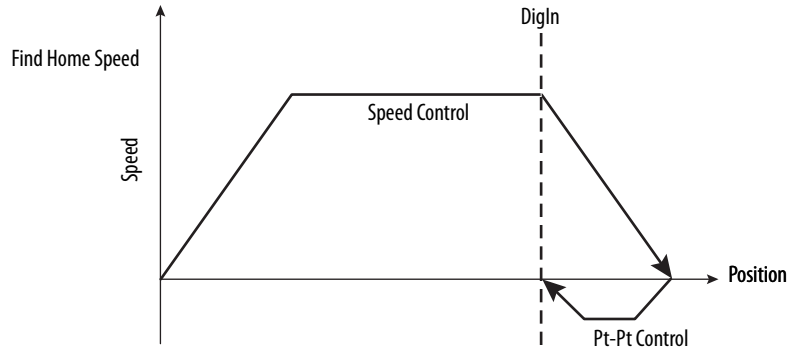
Upon activation of homing the drive will start moving in Speed Control mode, and ramp to the speed and direction set in P735[Find Home Speed] at the rate set in P736[Find Home Ramp]. When the limit/proximity switch is reached the "Homing Input" is set.

If P35[Motor Ctrl Mode] = 3 "Induction FV" P847[Psn Fdbk] count is latched and is considered the home position count. The drive will then ramp to zero at the rate set in P736[Find Home Ramp]. The drive will then perform a "point to point" position move back to the home position count in speed of 1/10 of P735[Find Home Speed]. When the motor is "At Position" and "At Zero Speed, the homing sequence will complete.

NOT Hold At Home, P731 Bit 7
If a position control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running, holding position and transferring position reference back to its previous source. If velocity control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running holding zero velocity and transferring velocity reference back to its previous source.

Hold At Home, P731 Bit 7
If a position control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running, holding position; drive will then transfer position reference back to its previous source once it receives a start command. If velocity control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue

running holding zero velocity; drive will then transfer velocity reference back to its previous source once it receives a start command.



If P35[Motor Ctrl Mode] = 0 "Induction VHz" or 1 "Induction SV"
The drive will then ramp to zero at the rate set in P736[Find Home Ramp].

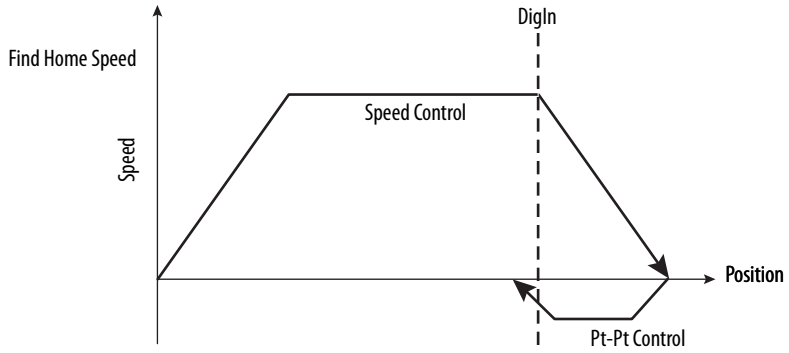
If the drive travels passed the proximity switch during decel
The drive will then reverse direction at a speed of 1/10 of P735[Find Home Speed]. The drive must then receive a rising edge of the proximity switch followed by a falling edge pulse. Upon receiving the falling edge pulse the drive will decel at rate set in P736[Find Home Ramp]. When the motor is "At Zero Speed," the homing sequence will complete.

If the drive remains on proximity switch during decel
The drive will reverse direction at a speed of 1/10 of P735[Find Home Speed]. When the falling edge of the limit/proximity switch is reached the drive decel at rate set in P736[Find Home Ramp]. When the motor is "At Zero Speed," the homing sequence will complete.

NOT Hold At Home, P731 Bit 7
If a position control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running, holding position and transferring position reference back to its previous source. If velocity control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running holding zero velocity and transferring velocity reference back to its previous source.

Hold At Home, P731 Bit 7
If a position control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue running, holding position; drive will then transfer position reference back to its previous source once it receives a start command. If velocity control type mode is selected in P313[Actv SpTqPs Mode] the drive will continue

running holding zero velocity; drive will then transfer velocity reference back to its previous source once it receives a start command.



Integrated Motion on the EtherNet/IP Network Applications for PowerFlex 755 AC Drives

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Additional Resources for Integrated Motion on the EtherNet/IP Network Information

These documents contain additional information on the Integrated Motion on the EtherNet/IP Network for PowerFlex 755 AC drive applications.

Resource	Description
PowerFlex 750-Series Drive Programming Manual, publication 750-PM001	Provides detailed information on: • I/O, control, and feedback options • Parameters and programming • Faults, alarms, and troubleshooting
PowerFlex 750-Series Drive Installation Instructions, publication 750-IN001	Provides instructions for: • Mechanical installation • Connecting incoming power, the motor, and basic I/O
PowerFlex 750-Series Drive Technical Data, publication 750-TD001	Provides detailed information on: • Drive specifications • Option specifications • Fuse and circuit breaker ratings
Integrated Motion on the Ethernet/IP Network User Manual, publication MOTION-UM003	Use this manual to configure an Integrated Motion on the Ethernet/IP network application and to start up your motion solution using the ControlLogix™ system.
Logix5000 Controllers Motion Instructions Reference Manual, publication MOTION-RM002	Provides details about the motion instructions that are available for a Logix5000 controller.
Kinetix® Motion Control Selection Guide, publication GMC-SG001	This selection guide is meant to help make initial decisions for the motion control products best suited for your system requirements. In addition, there are technical data publications with product specifications and design guide publications with selection information, specific to each drive family, to determine the accessories needed for your application. The design guides also include the recommended motor cables, performance specifications, and torque/speed (rotary) and force/velocity (linear) curves for each drive and motor/actuator combination.

You can view or download publications at http:/www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Software Tools

Integrated Architecture Builder can be downloaded at: http://www.rockwellautomation.com/en/e-tools/configuration.html

Motion Analyzer can be downloaded at: http://motion-analyzer.com/

Coarse Update Rate

The position loop for the PowerFlex 755 drive is updated at a rate of 1.024 ms (1024 µsec). During each position loop update the drive can either read or write data to the embedded Ethernet port, but cannot do both operations during the same update. Therefore the drive can receive only new updates every other position loop update event. To read new information from the Motion Planner (that is controller), the minimum coarse update rate must be 2.5 ms or greater to be sure that no data packets are lost. If the PowerFlex 755 drive is operated at a coarse update rate of less than 2.5 ms, data packets can be lost (resulting in the drive interpolating between missed updates), and/or the drive may fault if enough data packets are missed consecutively. Rockwell Automation recommends a minimum coarse update rate of 3 ms for the PowerFlex 755 drive.

Control Modes for PowerFlex 755 Drives Operating on the Integrated Motion on the EtherNet/IP Network

Integrated Motion on the EtherNet/IP network is a feature available with firmware revision 2.xxx and later for PowerFlex 755 drives. This feature provides a common user experience as with Kinetix 6500 drives when used with Logix controllers, revision 19 and later, on the EtherNet/IP network:

- The same motion profile in RSLogix 5000 provides a common configuration experience. The PowerFlex 755 drive uses the Motion Properties/Axis Properties and the same motion attributes as the Kinetix 6500 drive.
- The same RSLogix 5000 motion instructions provide a common programming experience.

Refer to the Integrated Motion on EtherNet/IP appendix in the PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001, for more information.

Motion Drive Start (MDS) Instruction

For information regarding the MDS instruction, refer to the Logix5000 Controllers Motion Instructions Reference Manual, publication MOTION-RM002.

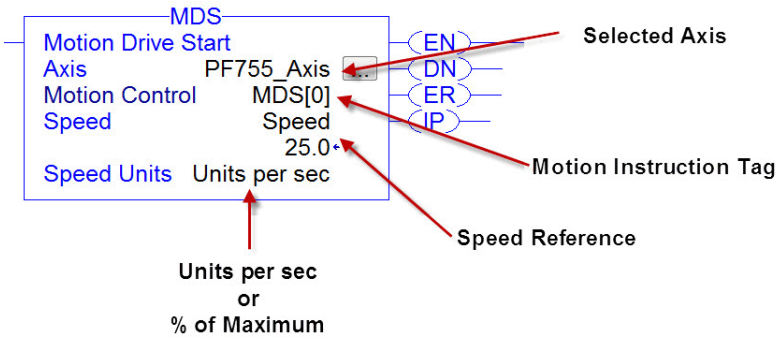
For the PowerFlex 755 drive, the MDS instruction is valid only when the axis configuration is set to one of these control modes:

- Frequency Control
- Velocity Loop
- Torque Loop

The MDS instruction is not valid when the axis configuration is set to Position Loop.

Motion Drive Start Instruction Configuration

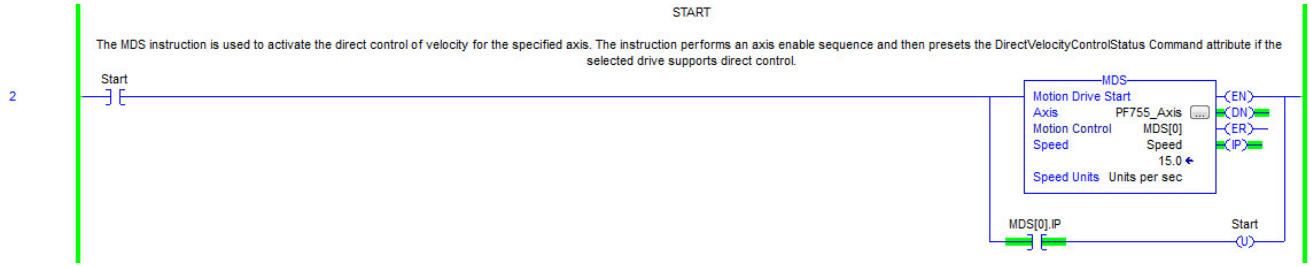
The MDS instruction is configured in a similar fashion to most motion instructions, as seen in this example.



The MDS instruction is similar to a Motion Axis Jog (MAJ) instruction, however the MDS instruction does not set the acceleration/deceleration rates. The acceleration rate is dynamically set by the ramp attributes configured in a Set System Value (SSV) instruction. See Ramp Attributes on page 218. Note that PF755_Axis was configured for revolutions. Therefore, the speed units are revs/sec.

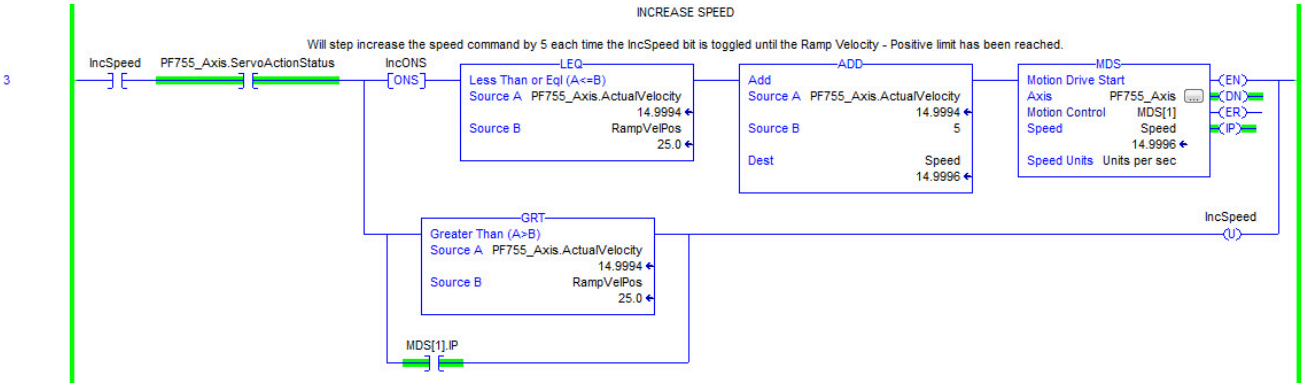
Motion Drive Start (MDS) Sample Code

Start



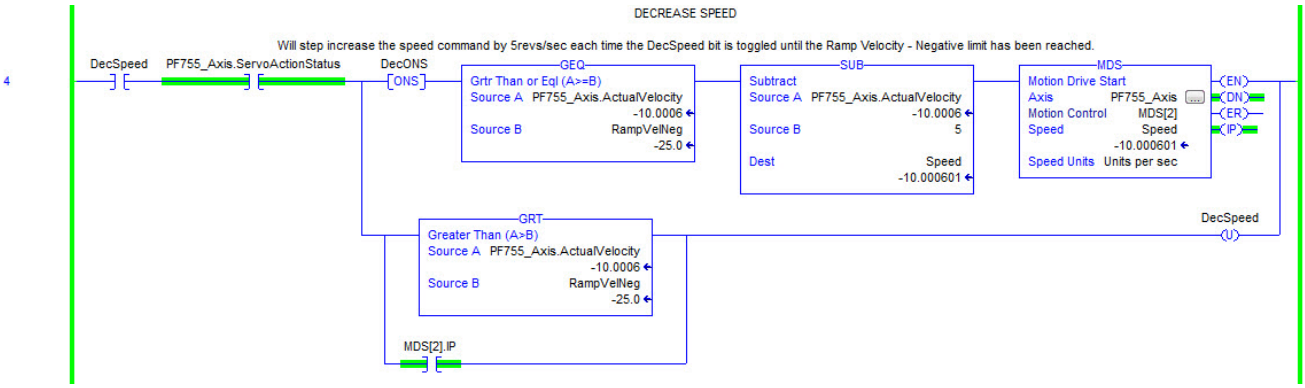
Increase Speed

The speed is changed by updating the speed reference and then re-executing the MDS instruction.



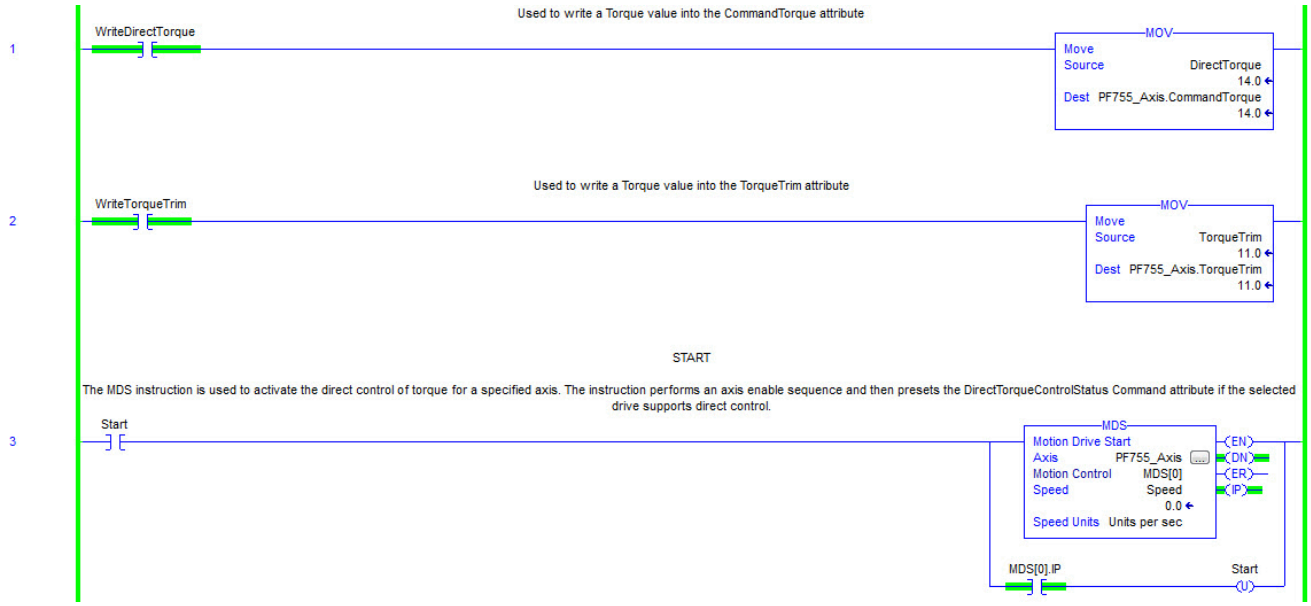
Decrease Speed

The speed is changed by updating the speed reference and then re-executing the MDS instruction.



Torque Mode

When the axis configuration is in Torque Loop, the Speed attribute within the MDS instruction is not used to command the speed of the drive. The speed is determined by the amount of torque specified in the CommandTorque and/or TorqueTrim attributes.



IMPORTANT You must command zero torque in the CommandTorque and TorqueTrim attributes before you use the Motion Axis Stop (MAS) instruction to stop a specific motion process on an axis or to stop the axis completely. To use the MAS instruction, you must set Change Decel to No. Otherwise an instruction error may occur. The deceleration rate is set based on the Ramp Deceleration attribute. The Motion Servo Off (MSF) instruction is used to deactivate the drive output for the specified axis and to deactivate the axis' servo loop. If you execute an MSF instruction while the axis is moving, the axis coasts to an uncontrolled stop.

Ramp Attributes

The MDS instruction is validated if the Integrated Motion on EtherNet/IP drive device supports the following five ramp attributes:

- RampAcceleration
- RampDeceleration
- RampVelocity - Positive
- RampVelocity - Negative
- RampJerk - Control

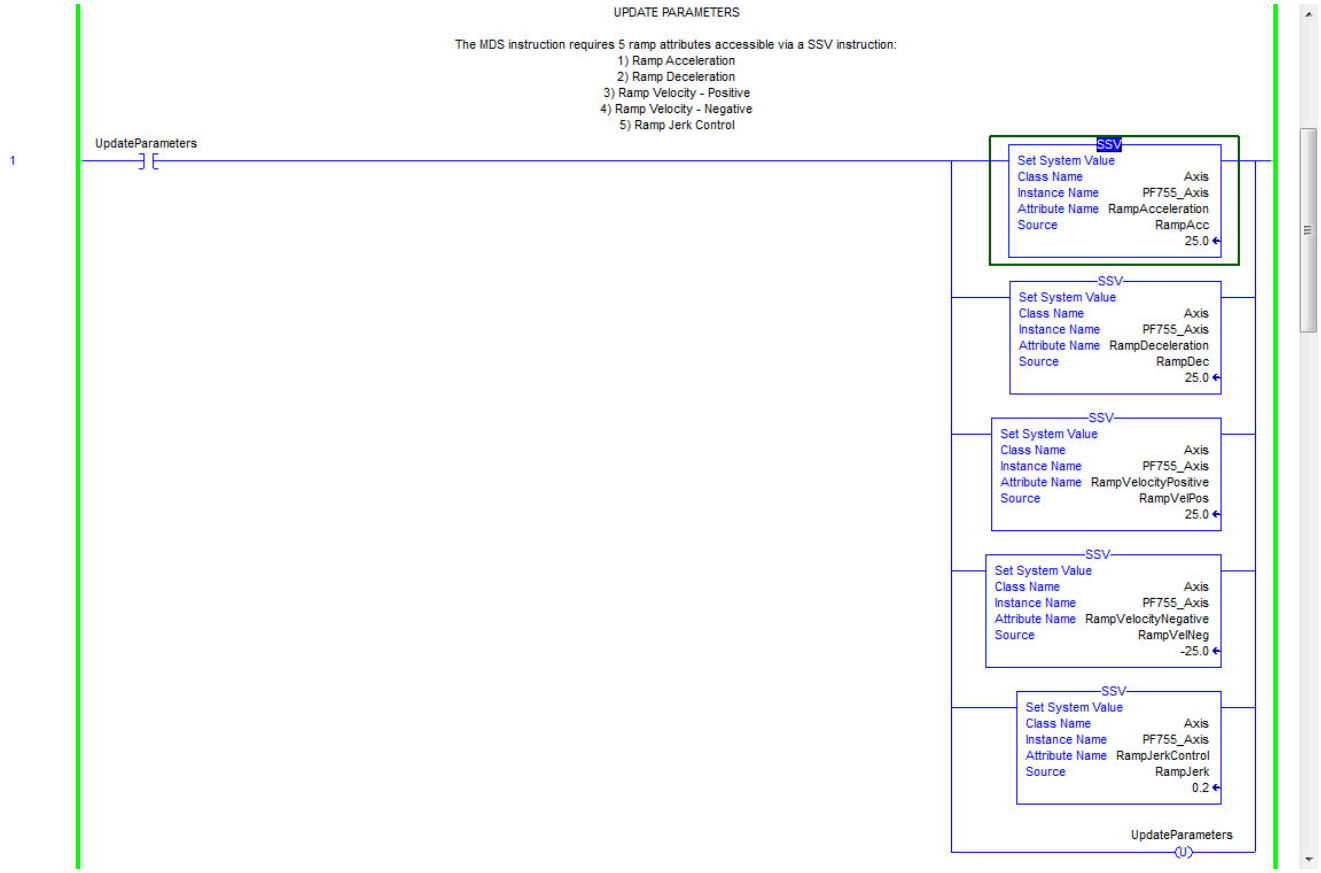
These ramp attributes are available only when the PowerFlex 755 drive axis configuration is set to Frequency Control or Velocity Loop. These ramp attributes are **not** available when the axis configuration is set to Torque Loop or Position Loop.

This table provides a cross reference between the PowerFlex 755 Integrated Motion on the EtherNet/IP Network Motion Ramp Attributes and the corresponding drive parameters.

Ramp Attribute	Drive Parameter
RampAcceleration	P535 [Accel Time 1]
RampDeceleration	P537 [Decel Time]
RampVelocity - Positive	P520 [Max Fwd Speed]
RampVelocity - Negative	P521 [Max Rev Speed]
RampJerk - Control	P540 [S Curve Accel] P541 [S Curve Decel]

Ramp Attribute Sample Code

The Ramp Attributes listed in the previous section are accessible via a RSLogix 5000 Set System Value (SSV) instruction, as shown in this example:

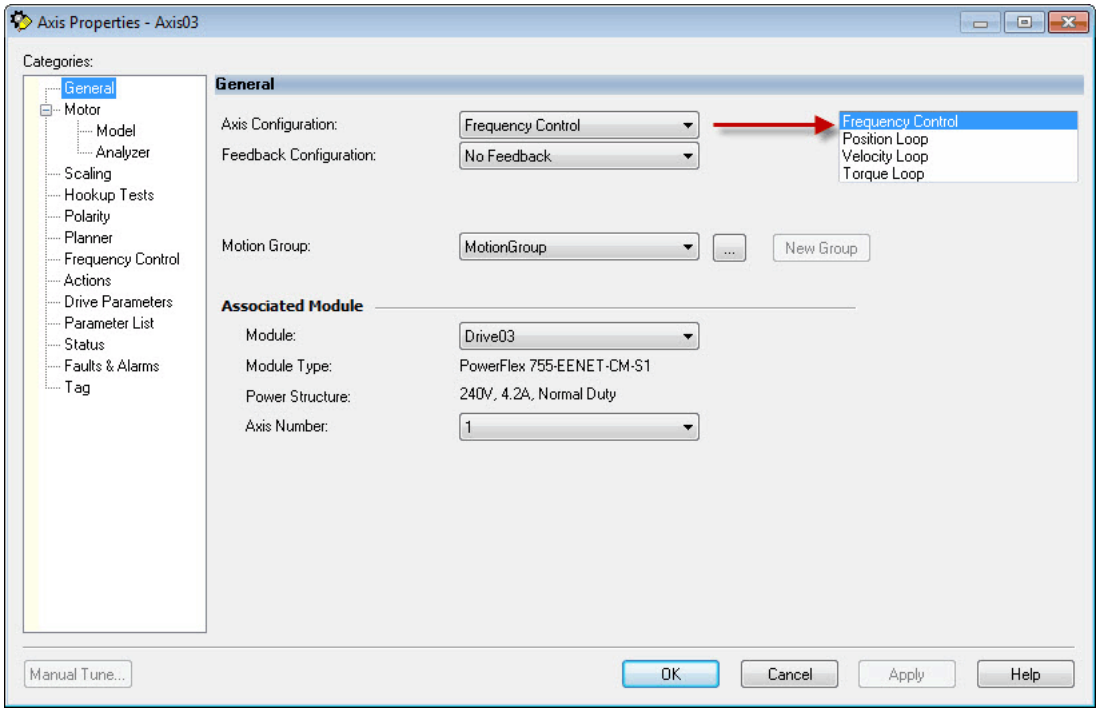


Position Mode, Velocity Mode, and Torque Mode Comparison

The PowerFlex 755 supports the following axis configurations:

- Frequency Control with No Feedback
- Position Loop with Motor Feedback, Dual Feedback or Dual Integral Feedback
- Velocity Loop with Motor Feedback or No Feedback
- Torque Loop with Motor Feedback

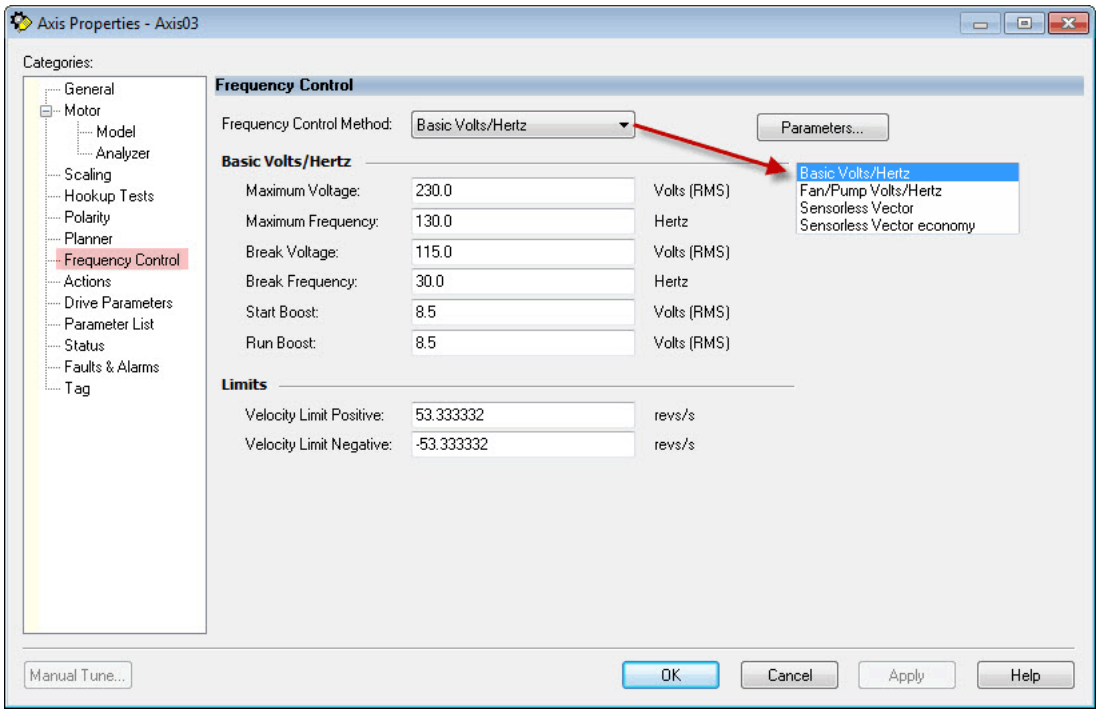
The selection options of the axis configuration within the RSLogix 5000, Axis Properties, General tab are shown here.



When the axis configuration is set to Frequency Control, you can select one of the following control methods that best suits the application:

- Basic Volts/Hertz
- Fan/Pump Volts/Hertz
- Sensorless Vector
- Induction FV

The selection options of the axis configuration within the RSLogix 5000 Axis Properties, Frequency Control tab are shown here.



This table contains the possible axis configurations and corresponding control modes of the PowerFlex 755 drive on the Integrated Motion on the EtherNet/IP Network.

Axis Configuration	P35 [Motor Ctrl Mode]	P65 [VHz Curve]
Frequency Control:		
Basic Volts/Hertz	InductionVHz	Custom V/Hz
Fan/Pump Volts/Hertz	InductionVHz	Fan/Pump
Sensorless Vector	Induction SV	Custom V/Hz
Sensorless Vector economy	Induct Econ	Custom V/Hz
Position Loop	Induction FV	Custom V/Hz
Velocity Loop	Induction FV	Custom V/Hz
Torque Loop	Induction FV	Custom V/Hz

For more detailed examples on PowerFlex 755 axis configurations, refer to the Axis Configuration Examples for the PowerFlex 755 Drive chapter in the Integrated Motion on the Ethernet/IP Network Configuration and Startup User Manual, publication MOTION-UM003.

Frequency Only

For information on the specific Frequency Control details, see the Motion Instructions and Integrated Motion Control Modes appendix in the Logix5000 Controllers Motion Instructions Reference Manual, publication MOTION-RM002.

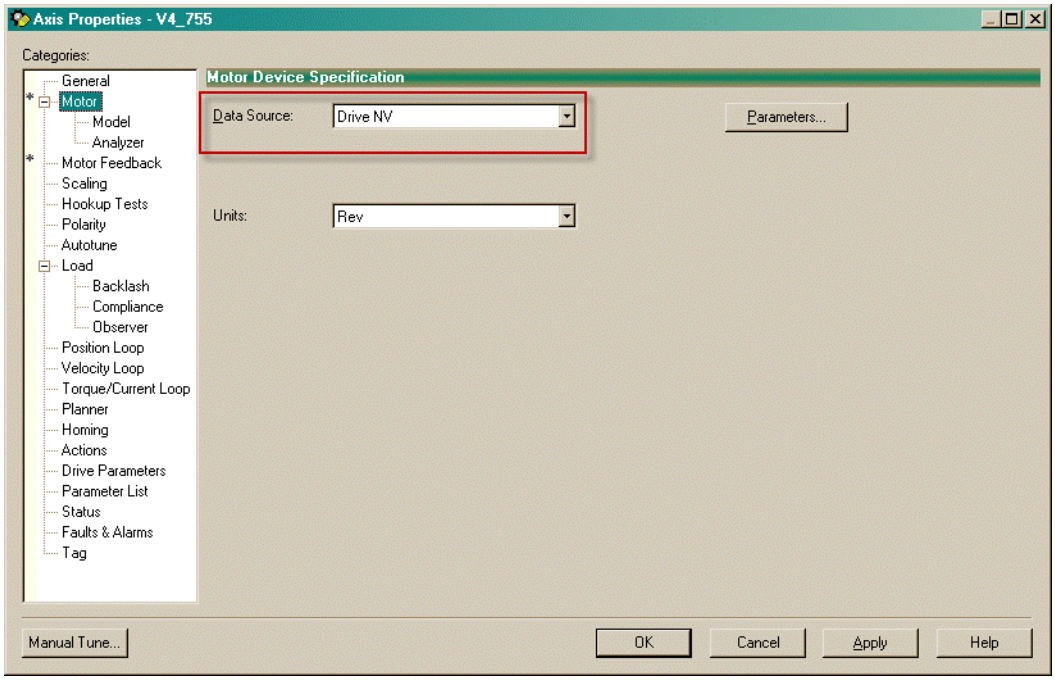
Drive Nonvolatile (NV) Memory for Permanent Magnet Motor Configuration

A Kinetix drive can automatically read configuration data in a permanent magnet motor/encoder's nonvolatile memory, whereas the motor/encoder configuration data must be manually entered and tuned in a PowerFlex 755 drive when configuring the drive and a permanent magnet motor for operation on the Integrated Motion on the EtherNet/IP Network.

The Drive NV option (shown in the screen example below) lets you start up a PowerFlex 755 drive and permanent magnet motor using the motor/encoder data that is entered and stored in the drive's nonvolatile memory. This is useful for a drive running in standalone mode that is being converted to operation on an Integrated Motion on the EtherNet/IP Network.

Use these settings to configure the drive module:

- Verify that the correct motor/encoder data is present in the drive.
- In the Axis Properties for the drive module, select the Motor category, and from the Data Source pull-down menu, choose Drive NV.
- Verify that the feedback selection in the appropriate drive parameter matches the selection in the Motor Feedback category for the axis.



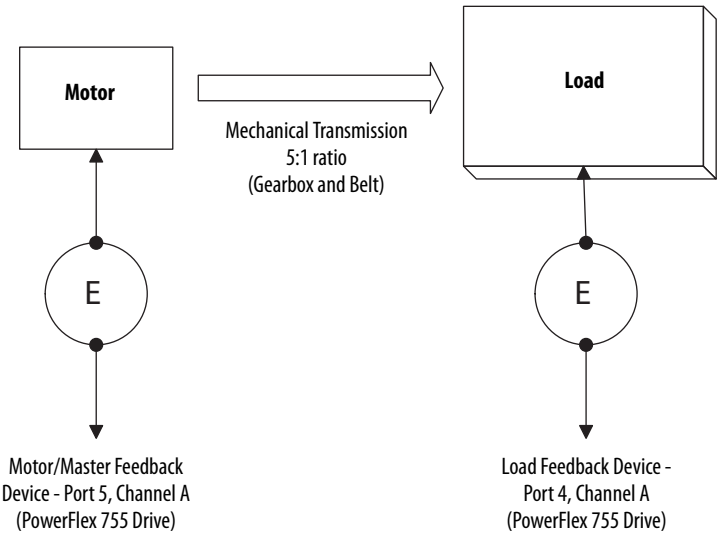
Dual Loop Control

This section explains how to configure a dual loop feedback application on the Integrated Motion on the EtherNet/IP Network for a PowerFlex 755 drive.

See the Integrated Motion on the EtherNet/IP Network Configuration and Startup User Manual, publication MOTION-UM003, for more information on configuring a PowerFlex 755 drive.

Dual Loop Application Description

A dual loop control application uses two encoders, one mounted on the motor (typical), and one mounted on the load (as depicted in this block diagram). The two encoders are connected to the PowerFlex 755 drive via separate feedback option modules, one installed in port 5, and another installed in port 4.

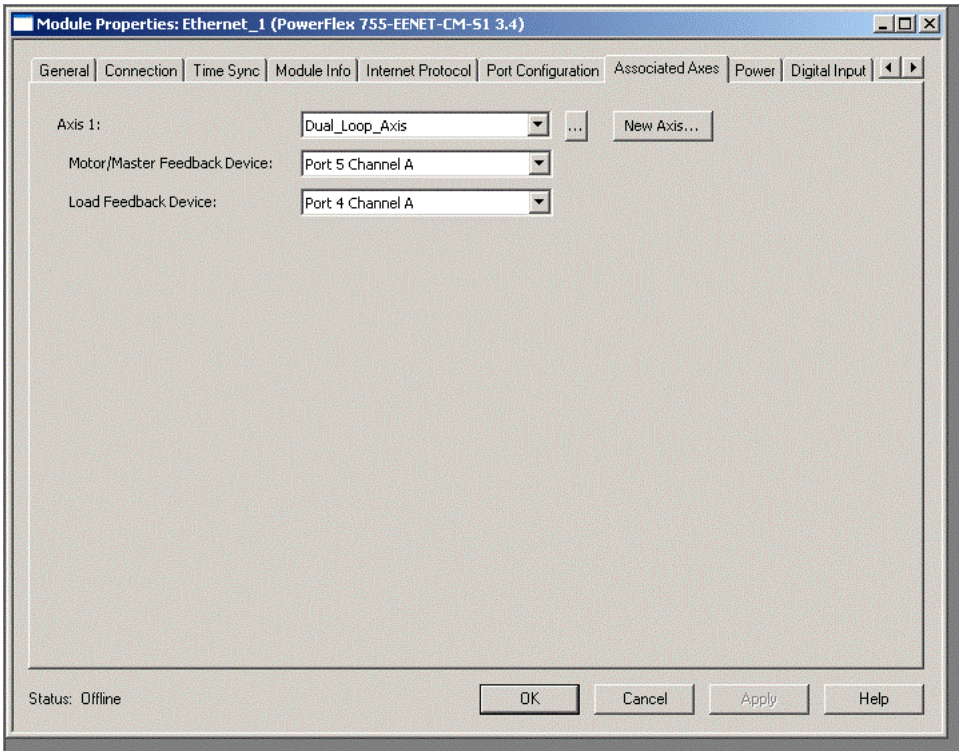


Dual Loop Control Configuration

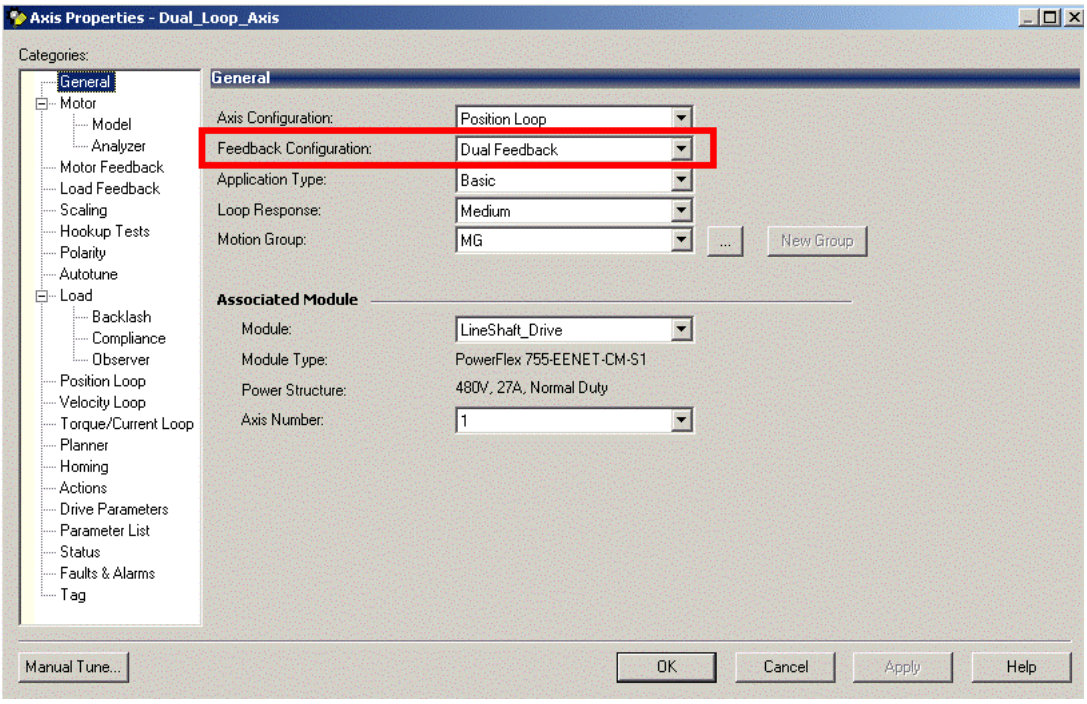
These steps assume that you have created an axis for the PowerFlex 755 drive in the Motion group and added a new PowerFlex 755 drive module in RSLogix 5000. See the Integrated Motion on the EtherNet/IP Network Configuration and Startup User Manual, publication MOTION-UM003, for complete procedures. Follow these steps to configure the dual loop control (encoder) axis.

1. Create a feedback axis in the Motion group for the encoders (Dual_Loop_Axis in this example).

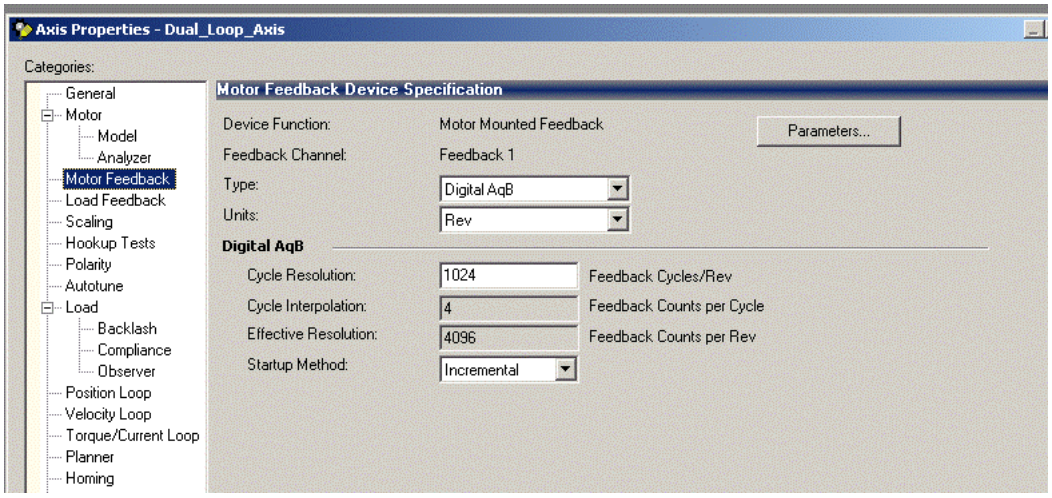
2. Open the PowerFlex 755 drive module and click the Associated Axis tab.
3. From the Axis 1 pull-down menu, choose the feedback axis you created (Dual_Loop_Axis in this example).
4. From the Motor/Master Feedback Device pull-down menu, choose Port 5 Channel A.
5. From the Load Feedback Device pull-down menu, choose Port 4 Channel A.
6. Click OK.



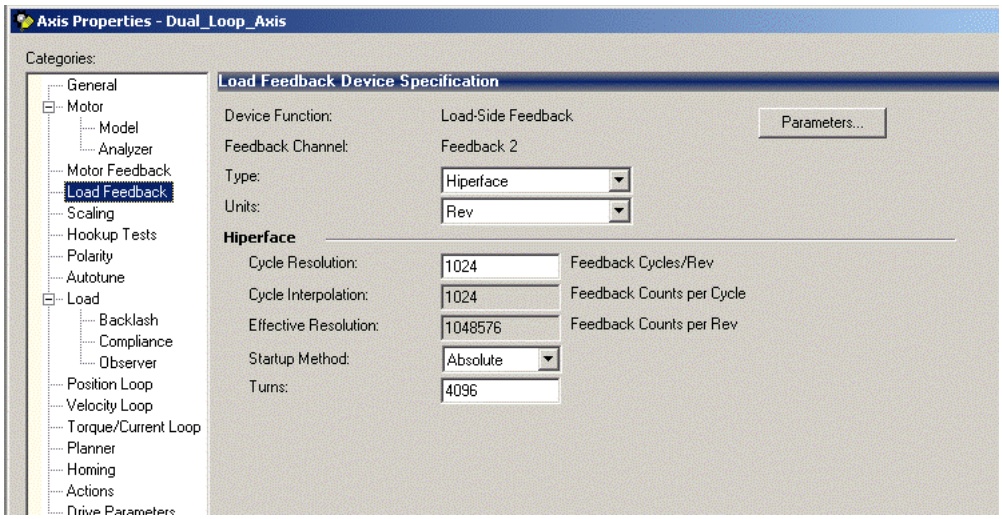
7. Open the Axis Properties for the feedback axis (Dual_Loop_Axis).
8. From the Feedback Configuration pull-down menu, choose Dual Feedback to allow the axis object to accept feedback from two sources.



9. Select the Motor Feedback category.
10. From the Type pull-down menu, choose the appropriate motor feedback.
11. In the Cycle Resolution box, type the appropriate value for your device.
12. From the Startup Method pull-down menu, choose the appropriate value for your device.



13. Select the Load Feedback category.
14. From the Type pull-down menu, choose the appropriate load feedback device.
15. From the Units pull-down menu, choose the appropriate value.
16. In the Cycle Resolution box, type the appropriate value for your device.
17. From the Startup Method pull-down menu, choose the appropriate value for your device.
18. In the Turns box, type the appropriate value for your device.

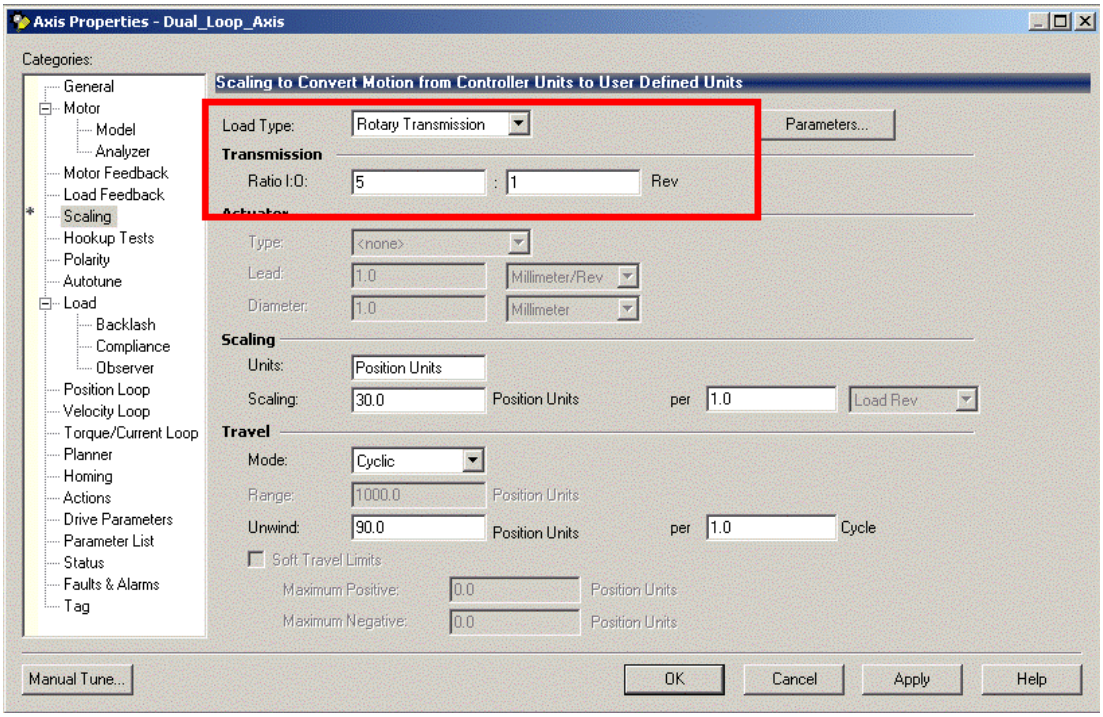


19. Select the Scaling category.
20. From the Load Type pull-down menu, choose the appropriate value for your device.

    This example uses a Rotary Transmission.
21. In the Transmission Ratio boxes, type the appropriate values for your device.

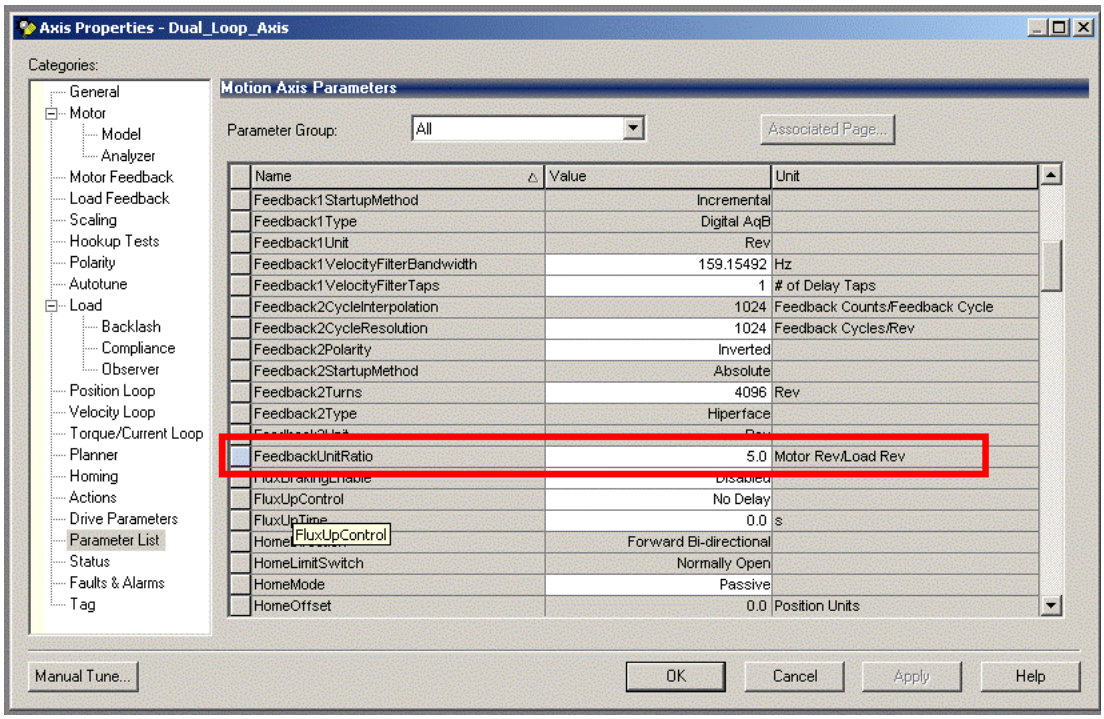
    This example uses a ratio of 5:1.
22. In the Scaling Units box, type the appropriate value for your device.
23. In the Scaling Position Units box, type the appropriate value for your device.

    This example uses 30 position units for every 1.0 load encoder revolution on a rotary axis (for example a dial), that unwinds to zero position after 90 units accumulate.



The velocity loop is controlled by the motor encoder feedback. Since a mechanical transmission exists between the motor and load side, the scaling units are potentially different between the two encoders.

24. To verify that the Motor to Load ratio is correct, select the Parameter List category.
25. View the value of the FeedbackUnitRatio parameter. In this example the ratio is 5:1, or 5 motor encoder revolutions to per load encoder revolution.



If the velocity loop is not performing well, that is, not following the command and not accelerating or decelerating properly, verify that this ratio is correct.

26. Continue by tuning this axis.

Dual-Port EtherNet/IP Option Module (ETAP)

The Dual-Port EtherNet/IP option module has two modes of operation, Adapter mode (default) and Tap mode.

Operation Mode Selection

The Tap mode is intended for use with PowerFlex 755 drives and uses the ENET3 (DEVICE) port as a connection point to transfer Integrated Motion on the EtherNet/IP Network data to the PowerFlex 755 drive's embedded EtherNet/IP adapter. The operation mode is selected by using the Operating Mode jumper (J4). For more information about setting the Operating Mode jumper, see the PowerFlex 20-750-ENETR Dual-Port EtherNet/IP Option Module User Manual, publication 750COM-UM008.

IP Address Assignment

If the PowerFlex 755 drive is connected to a Stratix 6000™ or Stratix 8000 managed Ethernet switch and the drive is set for BOOTP mode, the "dynamic IP address assignment by port" (Stratix 6000) or "DHCP persistence" (Stratix 8000) feature will set the IP address for the drive. For more details, see the Stratix 6000 Ethernet Managed Switch User Manual, publication 1783-UM001, or the Stratix 8000 and Stratix 8300™ Ethernet Managed Switches User Manual, publication 1783-UM003.

Option Module Placement

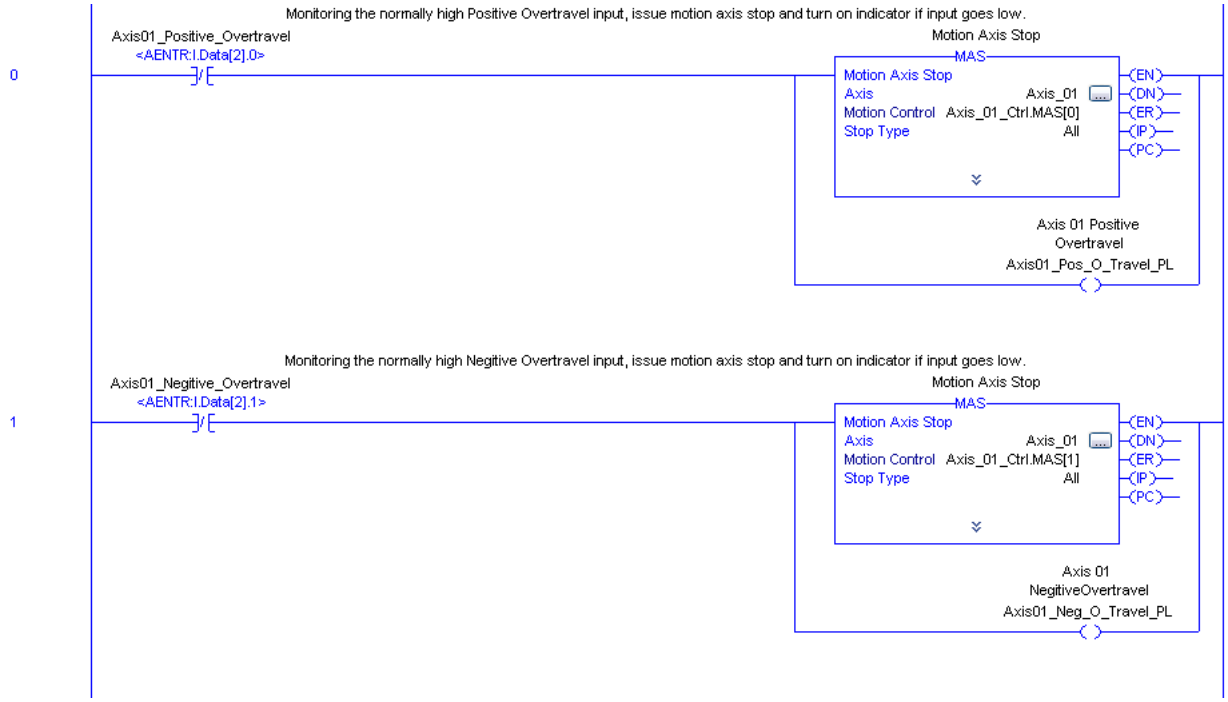
Install the Dual-Port EtherNet/IP option module in Port 4 or 5 of the PowerFlex 755 drive control pod. (When operating in Tap mode, drive Port 6 cannot be used.)

Hardware Over Travel Considerations

When a PowerFlex 755 drive is configured for Integrated Motion on the EtherNet/IP Network none of the I/O option modules are supported. Therefore, inputs associated with over-travel limits must be wired into controller input modules and then control must be programmed in the Logix Controller.

Operation of this control is accomplished by programming the controller to monitor the over travel limits via digital inputs and setting the desired action when over travel limits are exceeded. Possible actions include (but not limited to), setting an alarm, stopping the motion planner, stopping the drive, or performing a shutdown function.

The sample ladder logic code below depicts a possible solution for performing hardware over travel control (the code is an example only and is not the only solution for monitoring hardware over travel limits). Each individual application will determine the requirements for the necessary hardware over travel control. This example monitors digital inputs and issues a motion axis stop if either input goes false and generates an output indicator that could be used to annunciate the stop.

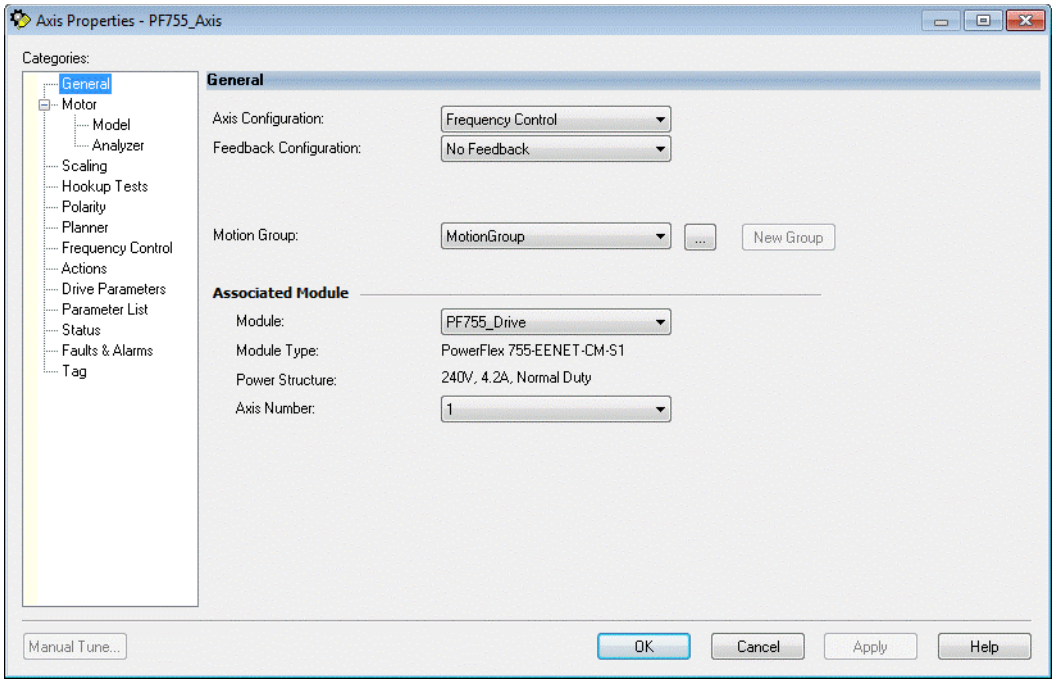


Integrated Motion on EtherNet/IP Instance to PowerFlex 755 Drive Parameter Cross-Reference

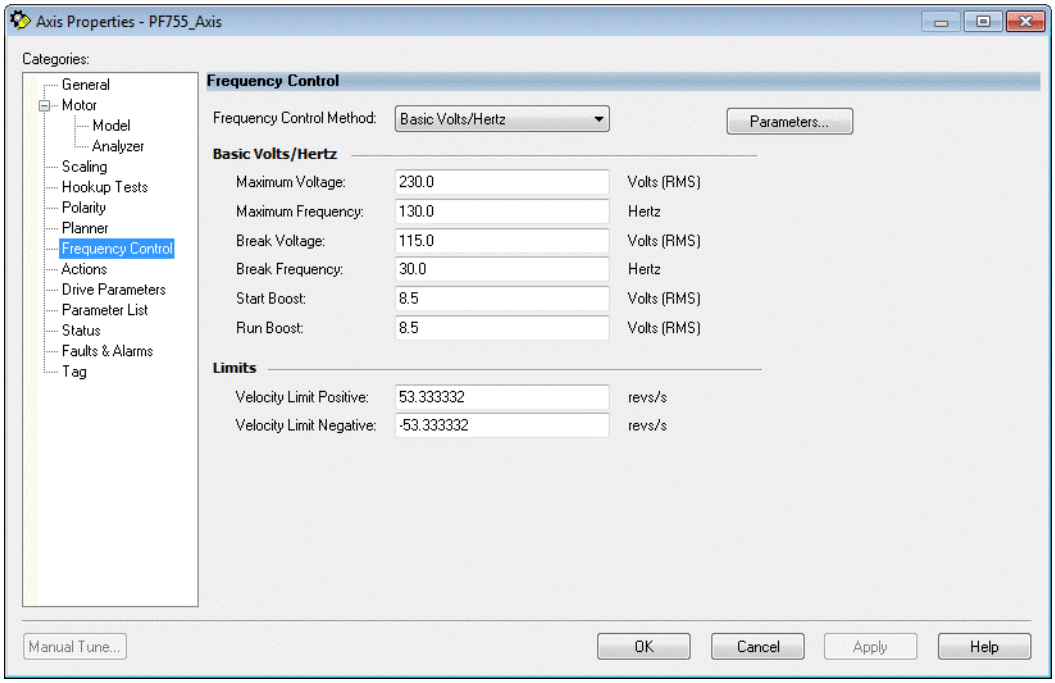
This section cross-references the RSLogix 5000 Module Properties and Axis Properties instance to the corresponding PowerFlex 755 drive parameter. See the PowerFlex 755 Standard and Safety Drive Module Optional Attributes appendix in this manual for details on optional attributes and the corresponding control mode functionality supported by a PowerFlex 755 drive module.

Frequency Control Axis Properties Configuration

General Axis Properties for Frequency Control



Frequency Control Axis Properties



Frequency Control Motion Axis Parameters

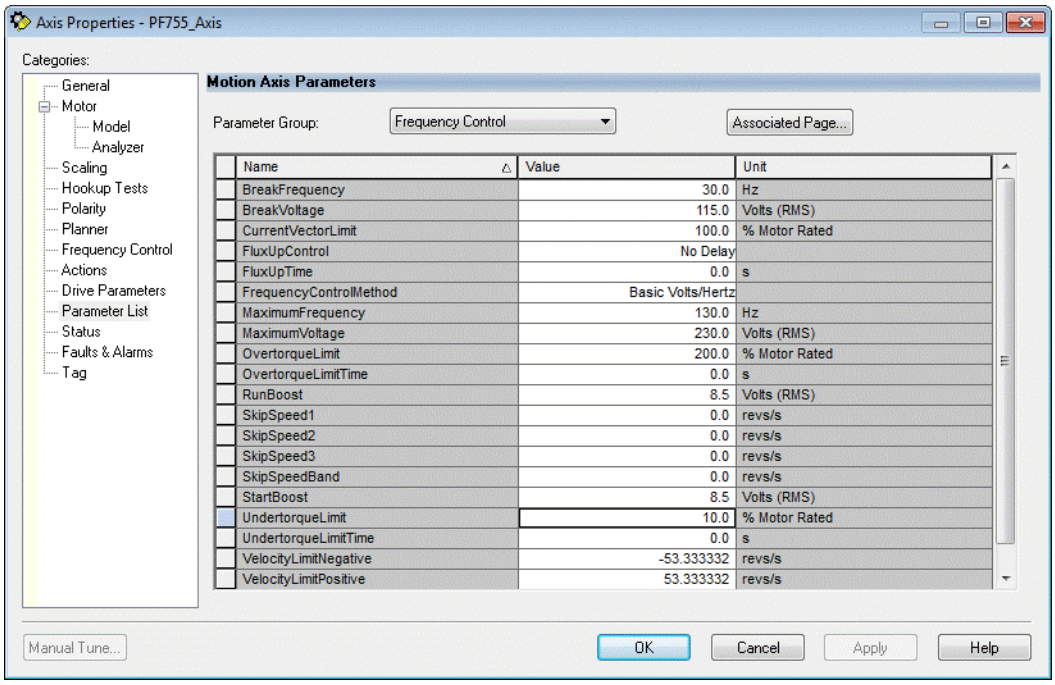
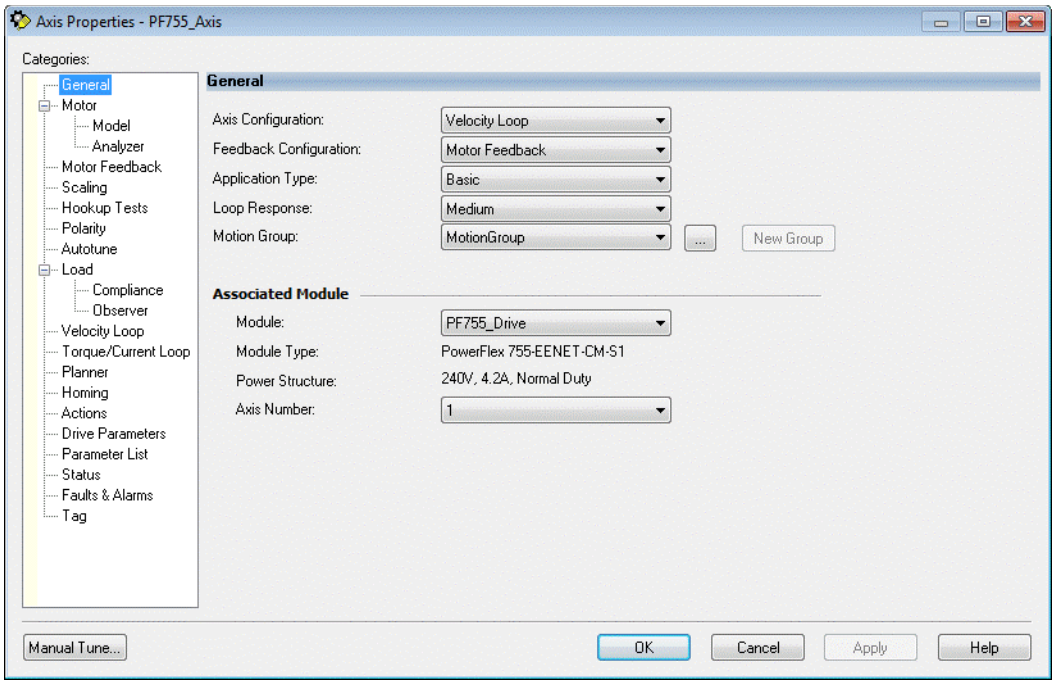


Table 9 - Frequency Control Instance to Parameter Cross Reference

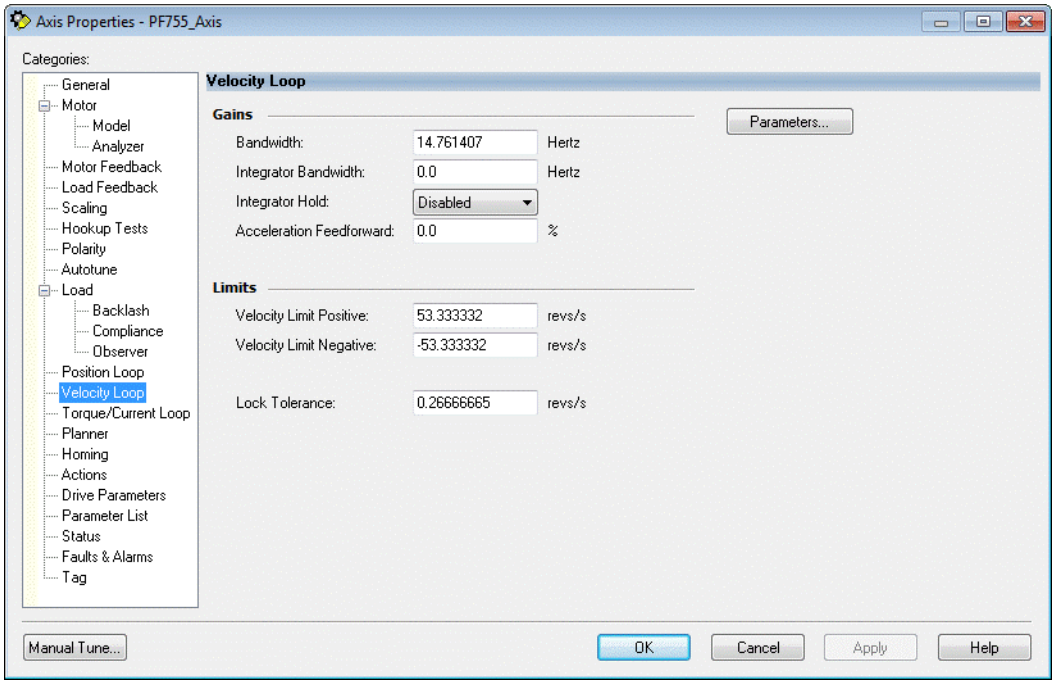
Integrated Motion on EtherNet/IP Instance	Drive Parameter
Break Frequency	P63 [Break Frequency]
Break Voltage	P62 [Break Voltage]
Current Vector Limit	P422 [Current Limit 1]
Flux Up Control	P43 [Flux Up Enable] – Forced to Automatic
Flux Up Time	P44 [Flux Up Time]
Frequency Control Method	P65 [VHz Curve]
Maximum Frequency	P37 [Maximum Freq]
Overtorque Limit	P436 [Shear Pin1 Level]
Overtorque Limit Time	P437 [Shear Pin 1 Time]
Run Boost	P61 [Run Boost]
Skip Speed 1	P526 [Skip Speed 1]
Skip Speed 2	P527 [Skip Speed 2]
Skip Speed 3	P528 [Skip Speed 3]
Skip Speed Band	P529 [Skip Speed Band]
Start Boost	P60 [Start Acc Boost]
Undertorque Limit	P442 [Load Loss Level]
Undertorque Limit Time	P443 [Load Loss Time]
Velocity Droop	P620 [Droop RPM at FLA]
Velocity Limit Negative	P521 [Max Rev Speed]
Velocity Limit Positive	P520 [Max Fwd Speed]

Velocity Control Axis Properties Configuration

General Axis Properties for Velocity Control



Velocity Control Axis Properties



Velocity Control Motion Axis Parameters

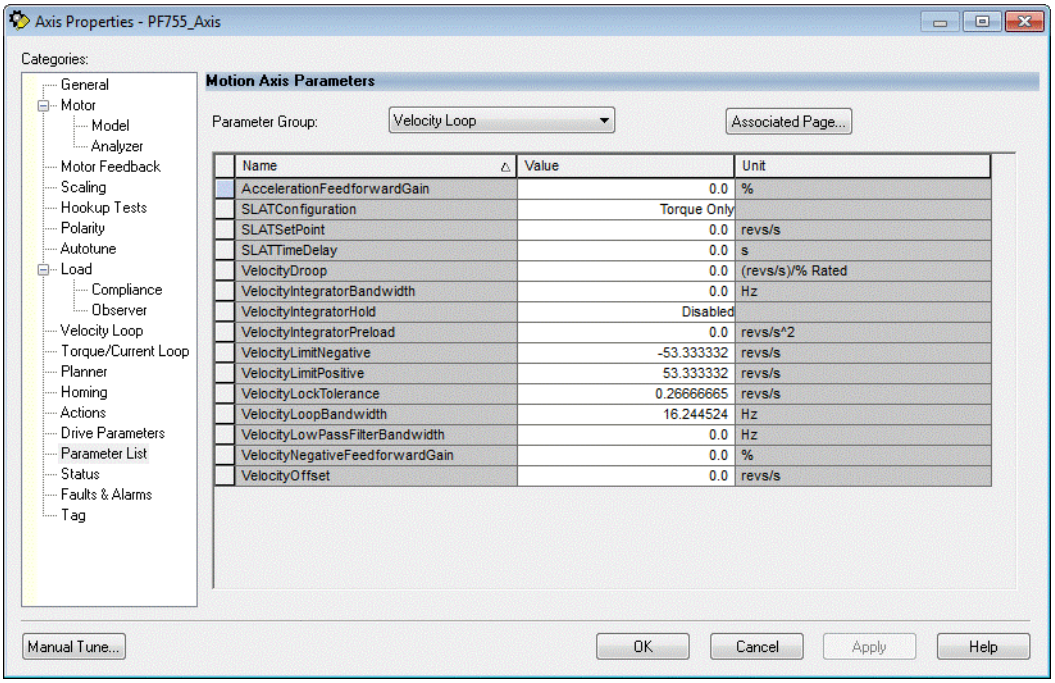
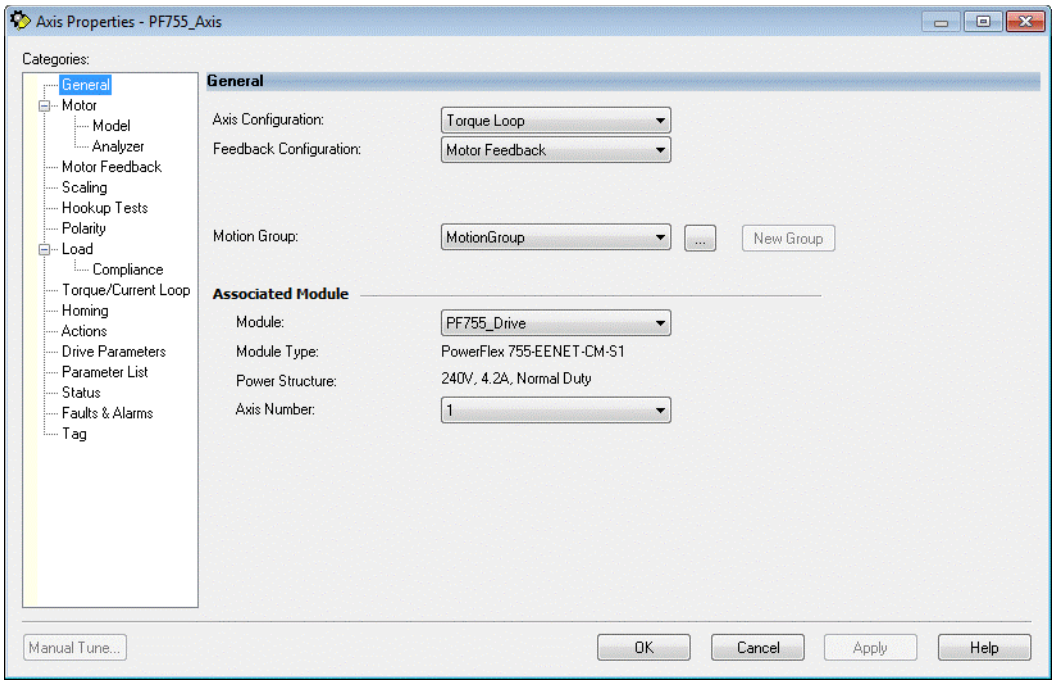


Table 10 - Velocity Control Instance to Parameter Cross Reference

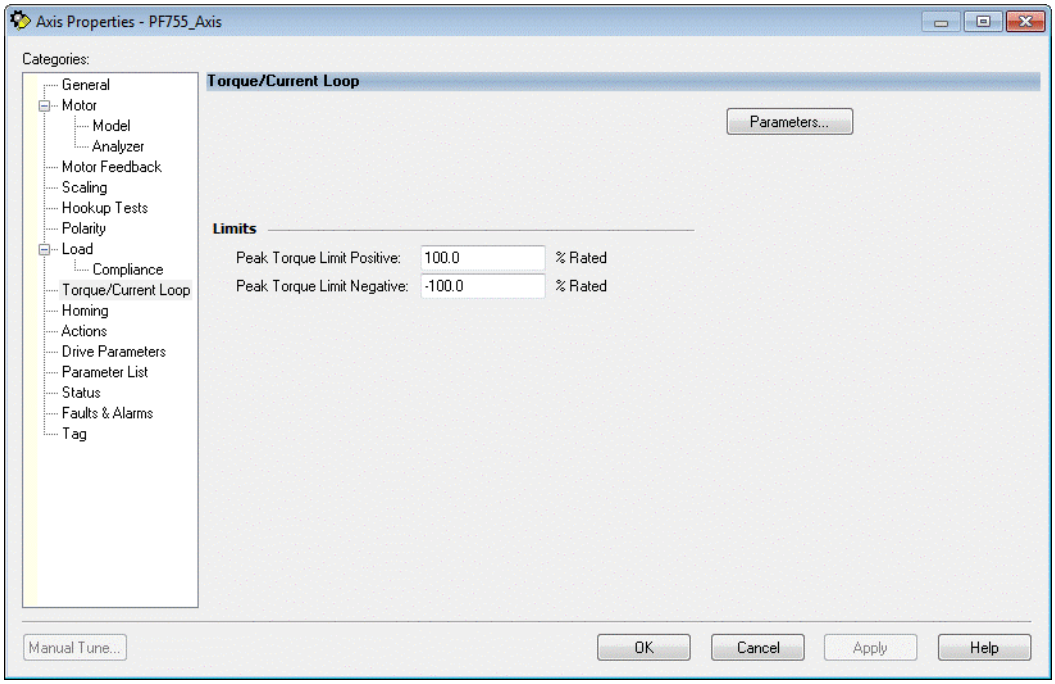
Integrated Motion on EtherNet/IP Instance	Drive Parameter
Acceleration Feed Forward Gain	P696 [Inertia Acc Gain] P697 [Inertia Dec Gain]
SLAT Configuration	P309 [SpdTrqPsn Mode A]
SLAT Set Point	P314 [SLAT Err Stpt]
SLAT Time Delay	P315 [SLAT Dwell Time]
Velocity Droop	P620 [Droop RPM at FLA]
Velocity Integrator Bandwidth	P647 [Speed Reg Ki]
Velocity Integrator Hold	P635 [Spd Options Ctrl]
Velocity Integrator Preload	P652 [SReg Trq Preset]
Velocity Limit Negative	P521 [Max Rev Speed]
Velocity Limit Positive	P520 [Max Fwd Speed]
Velocity Loop Bandwidth	P645 [Speed Reg Kp]
Velocity Low Pass Filter Bandwidth	P644 [Spd Err Fltr BW]
Velocity Negative Feed Forward Gain	P643 [SpdReg AntiBckup]
Velocity Offset	P601 [Trim Ref A Stpt]

Torque Loop Axis Properties Configuration

General Axis Properties for Torque Loop



Torque Loop Axis Properties



Torque Loop Motion Axis Parameters

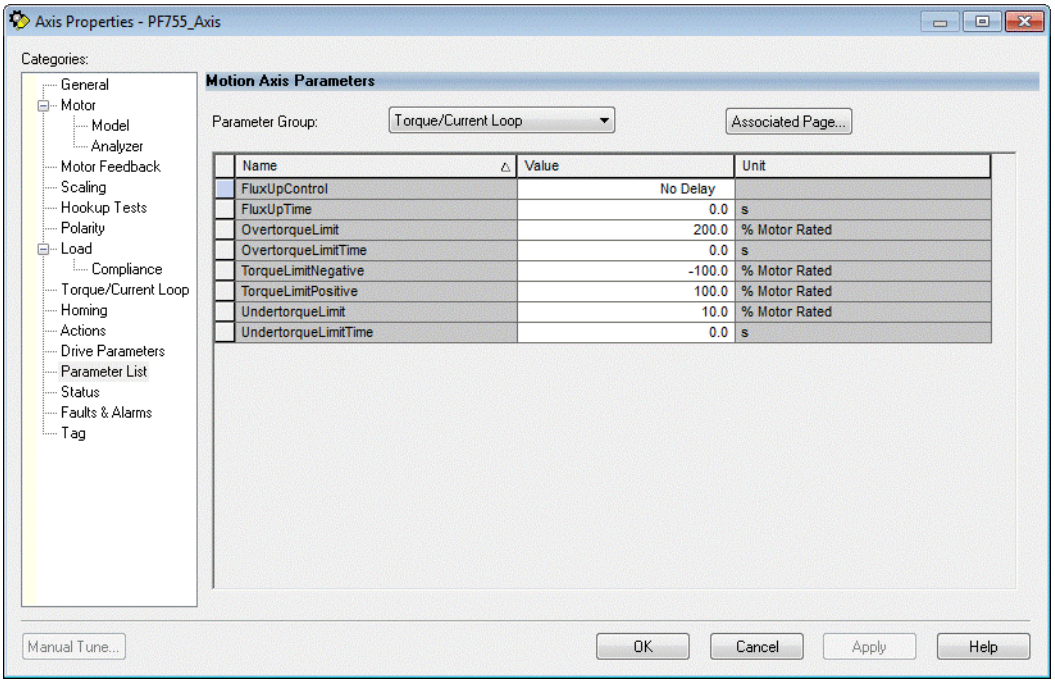
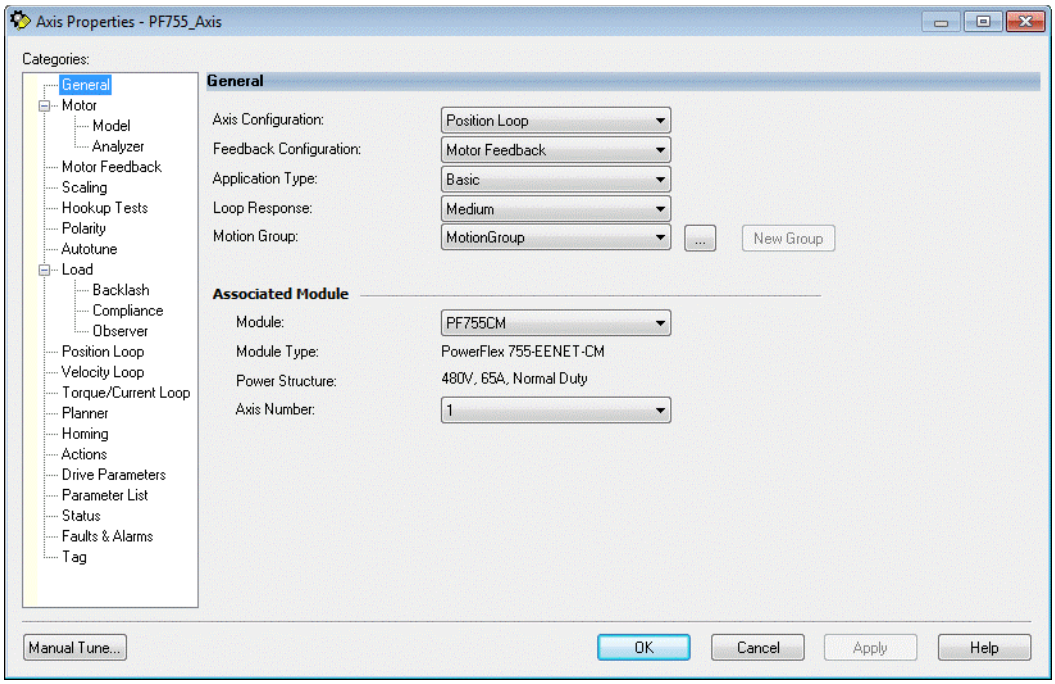


Table 11 - Torque Loop Instance to Parameter Cross Reference

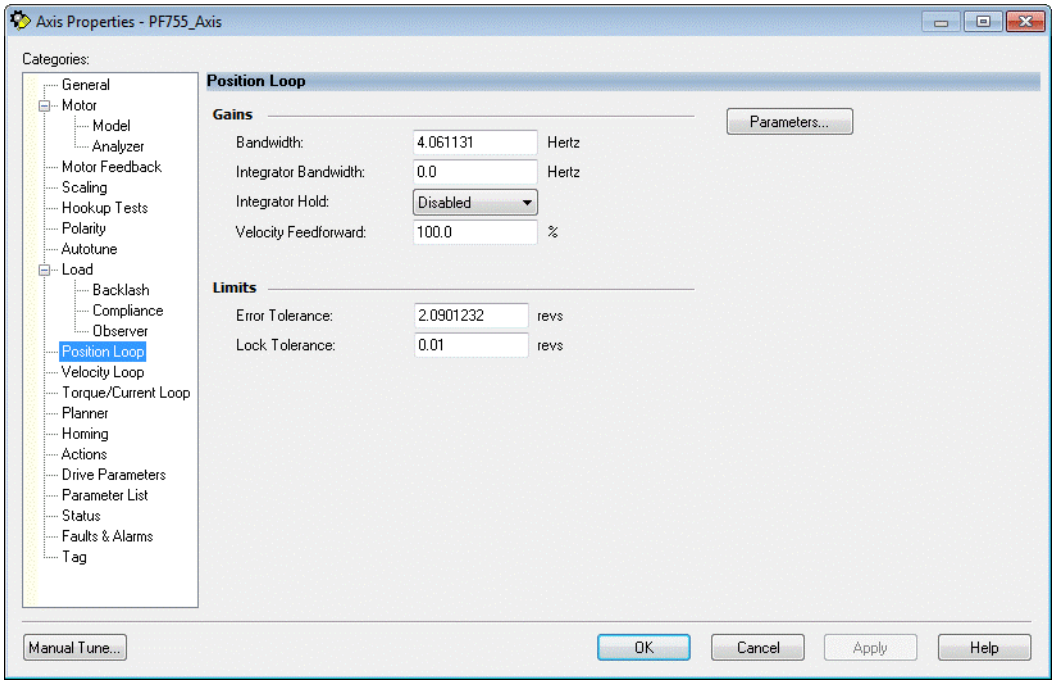
Integrated Motion on EtherNet/IP Instance	Drive Parameter
Flux Up Control	P43 [Flux Up Enable] – Forced to Automatic
Flux Up Time	P44 [Flux Up Time]
Overtorque Limit	P436 [Shear Pin1 Level]
Overtorque Limit Time	P437 [Shear Pin 1 Time]
Torque Limit Negative	P671 [Neg Torque Limit]
Torque Limit Positive	P670 [Pos Torque Limit]
Undertorque Limit	P442 [Load Loss Level]
Undertorque Limit Time	P443 [Load Loss Time]

Position Loop Axis Properties Configuration

General Axis Properties for Position Loop



Position Loop Axis Properties



Position Loop Motion Axis Parameters

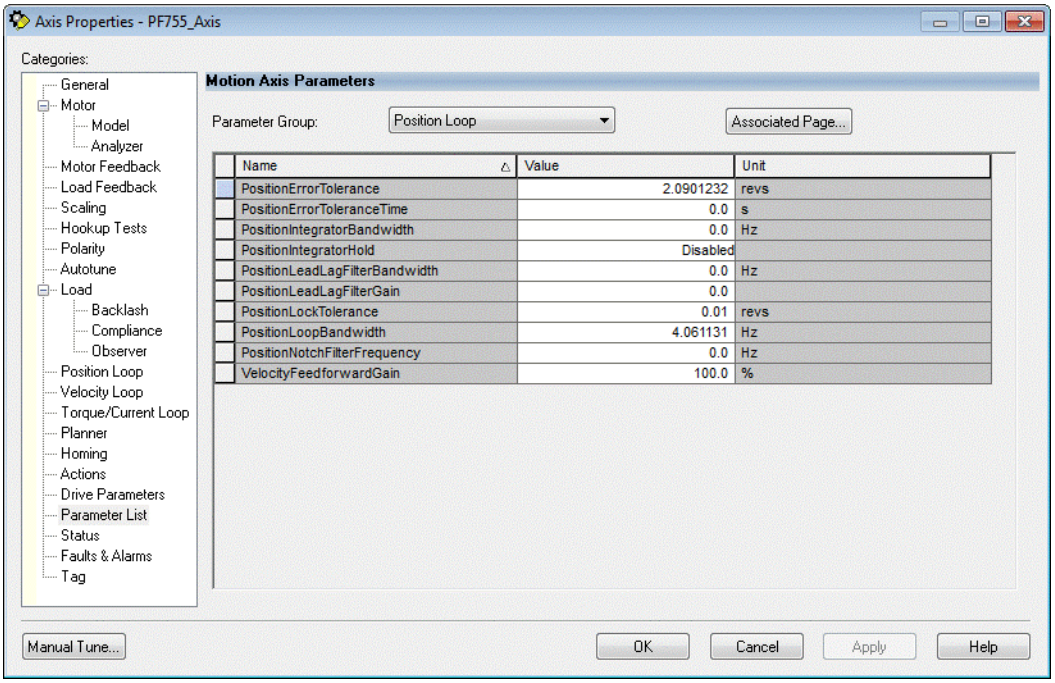
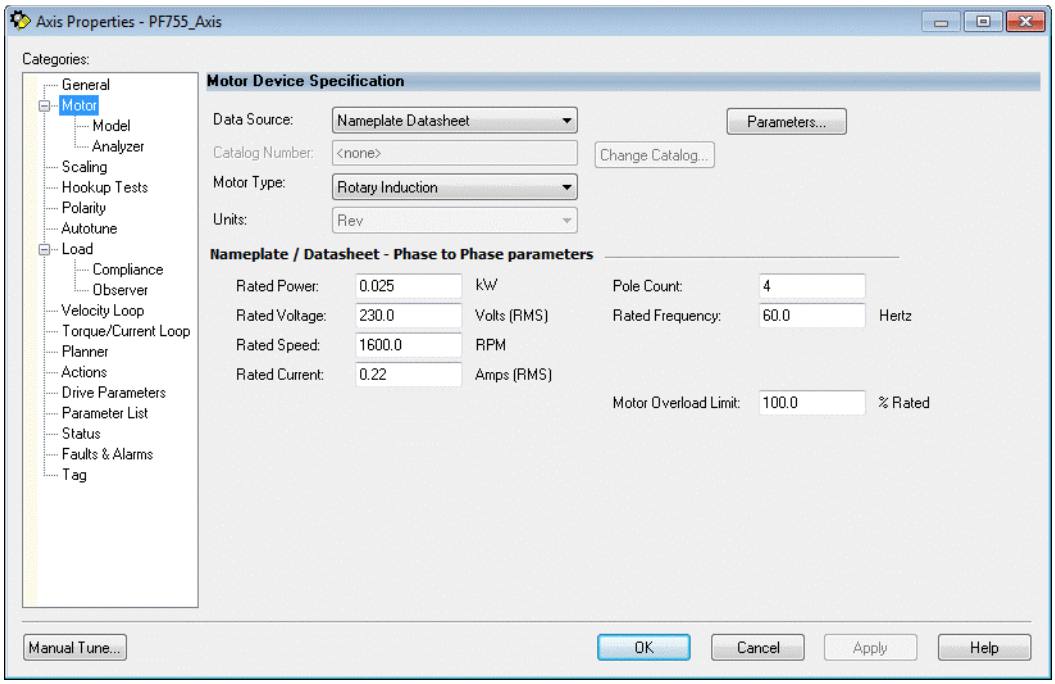


Table 12 - Position Loop Instance to Parameter Cross Reference

Integrated Motion on EtherNet/IP Instance	Drive Parameter
Position Integrator Bandwidth	P838 [Psn Reg Ki]
Position Integrator Hold	P721 [Position Control]
Position Lead Lag Filter Bandwidth	P834 [Psn Out Fltr BW]
Position Lead Lag Filter Gain	P833 [Psn Out FltrGain]
Position Loop Bandwidth	P839 [Psn Reg Kp]
Position Notch Filter Frequency	P830 [PsnNtchFltrFreq]
Velocity Feed Forward Gain	P549 [Spd Ref A Mult]

Induction Motor Data Axis Properties Configuration

Induction Motor Data Axis Properties



Induction Motor Data Motion Axis Parameters

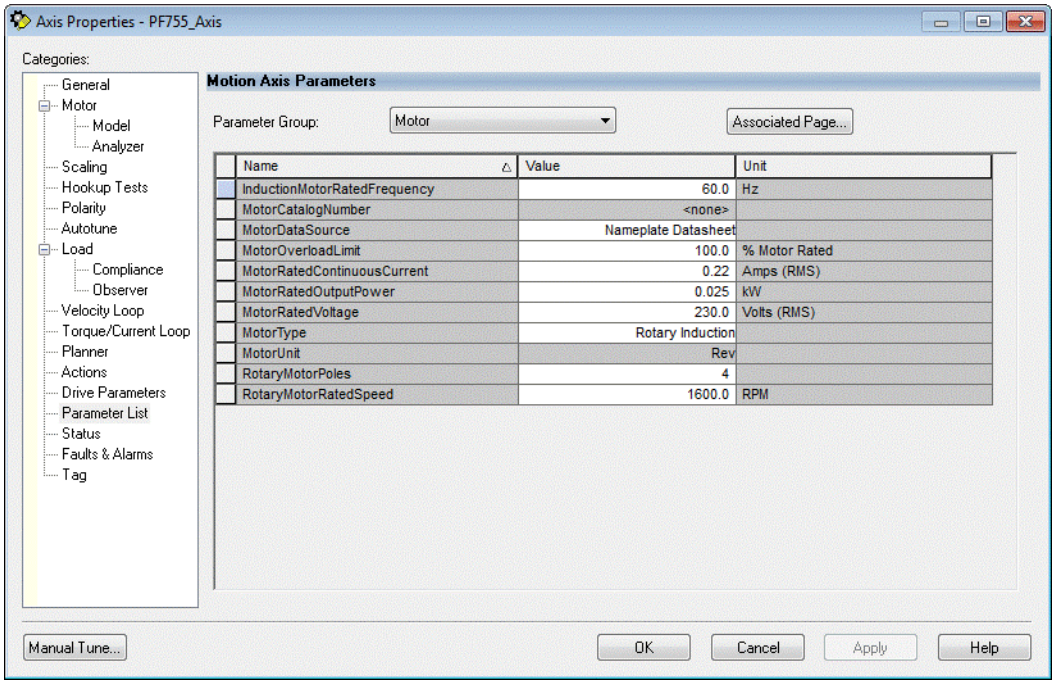


Table 13 - Induction Motor Data Instance to Parameter Cross Reference

Integrated Motion on EtherNet/IP Instance	Drive Parameter
Induction Motor Rated Frequency	P27 [Motor NP Hertz]
Motor Overload Limit	P413 [Mtr OL Factor]
Motor Rated Continuous Current	P26 [Motor NP Amps]
Motor Rated Output Power	P30 [Motor NP Power]
Motor Rated Voltage	P25 [Motor NP Volts]
Motor Type	P35 [Motor Cntl Mode]
Rotary Motor Poles	P31 [Motor Poles]
Rotary Motor Rated Speed	P28 [Motor NP RPM]

Induction Motor Model Axis Properties Configuration

Induction Motor Model Motion Axis Parameters

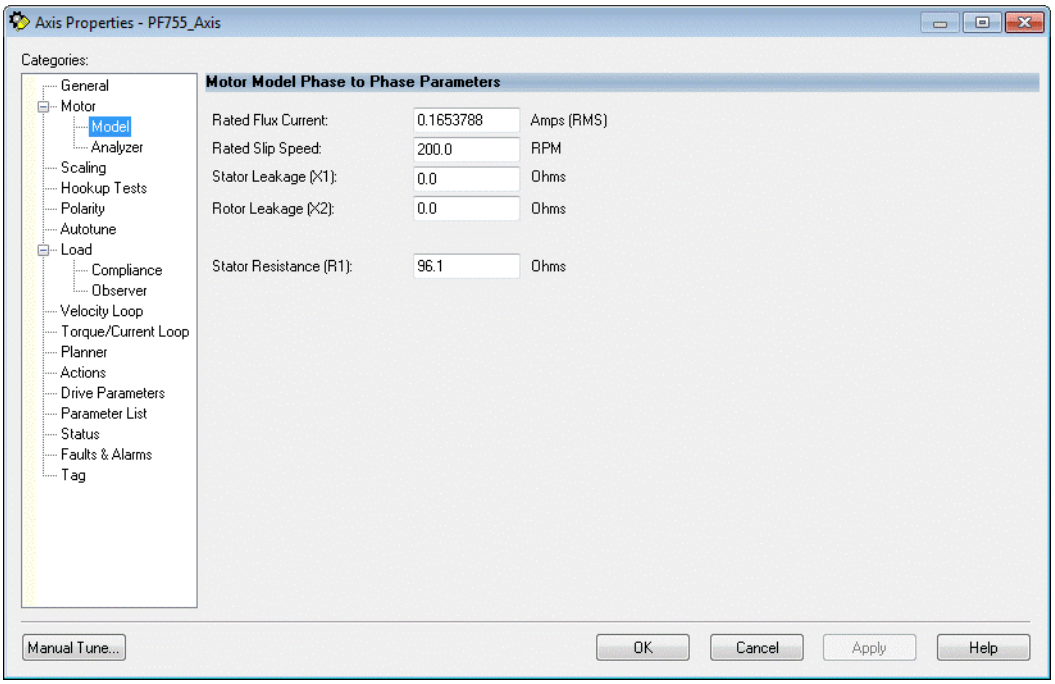
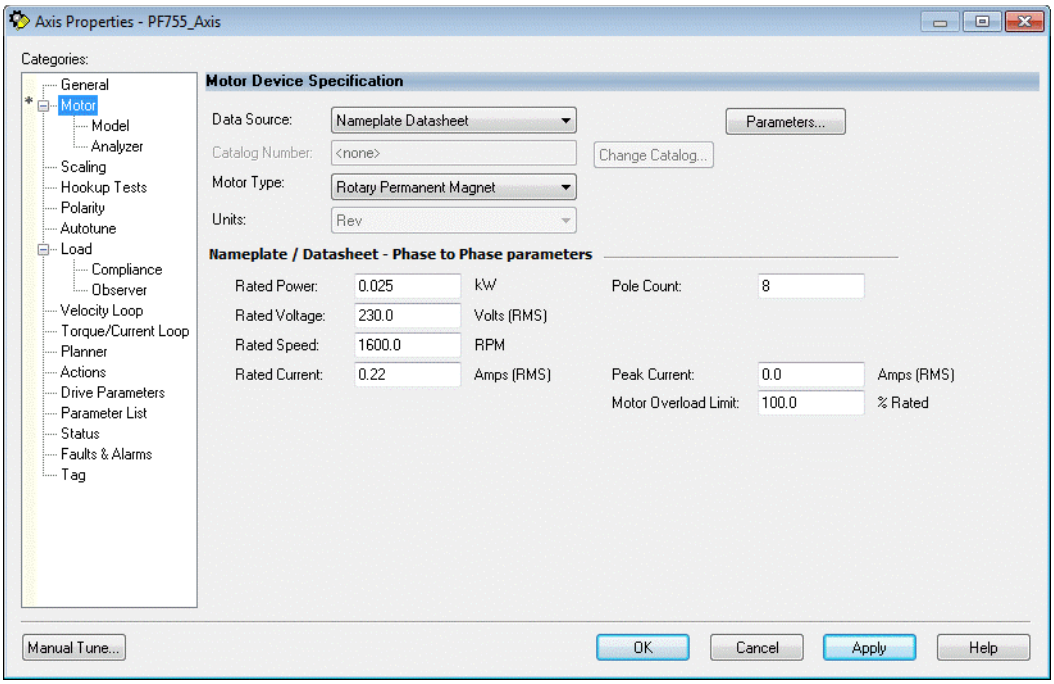


Table 14 - Induction Motor Model Instance to Parameter Cross Reference

Integrated Motion on EtherNet/IP Instance	Drive Parameter
Induction Motor Flux Current	P75 [Flux Current Ref]
Induction Motor Rated Slip Speed	P621 [Slip RPM at FLA]
Induction Motor Stator Leakage Resistance	P74 [Ixo Voltage Drop]
Induction Motor Rotor Leakage Resistance	P74 [Ixo Voltage Drop]
Induction Motor Stator Resistance	P73 [IR Voltage Drop]

Permanent Magnet Motor Data Axis Properties Configuration

Permanent Magnet Motor Data Axis Properties



Permanent Magnet Motor Data Motion Axis Parameters

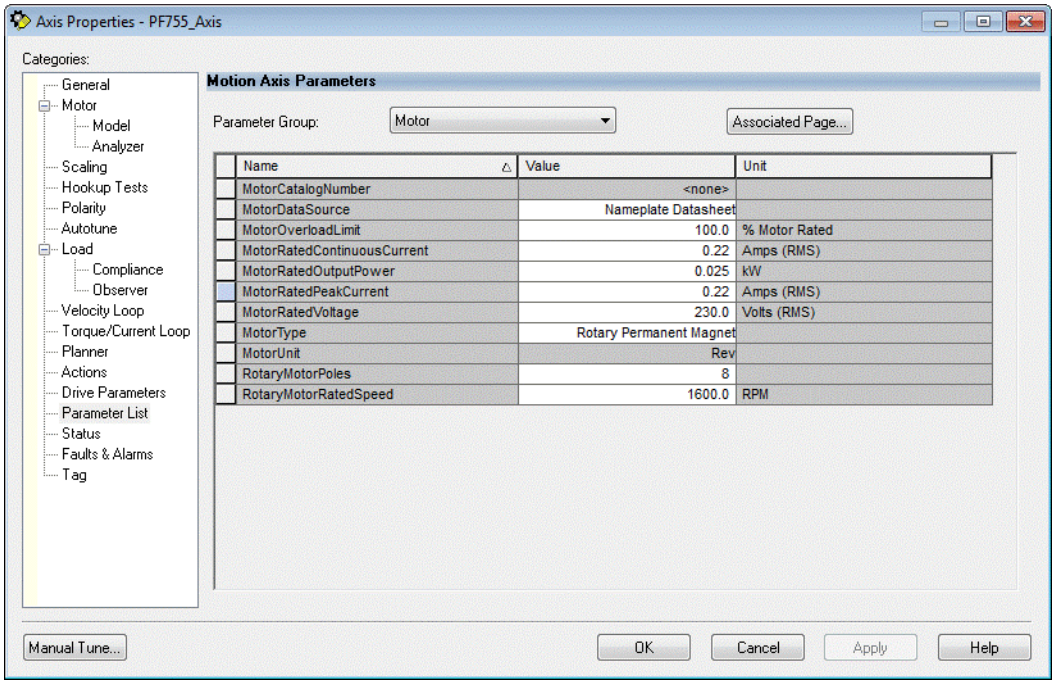


Table 15 - Permanent Magnet Motor Data Instance to Parameter Cross Reference

Integrated Motion on EtherNet/IP Instance	Drive Parameter
Motor Overload Limit	P413 [Mtr OL Factor]
Motor Rated Continuous Current	P26 [Motor NP Amps]
Motor Rated Output Power	P30 [Motor NP Power]
Motor Rated Peak Current	P422 [Current Limit 1]
Motor Rated Voltage	P25 [Motor NP Volts]
Motor Type	P35 [Motor Cntl Mode]
Rotary Motor Poles	P31 [Motor Poles]
Rotary Motor Rated Speed	P28 [Motor NP RPM]

Permanent Magnet Motor Model Motion Axis Parameters

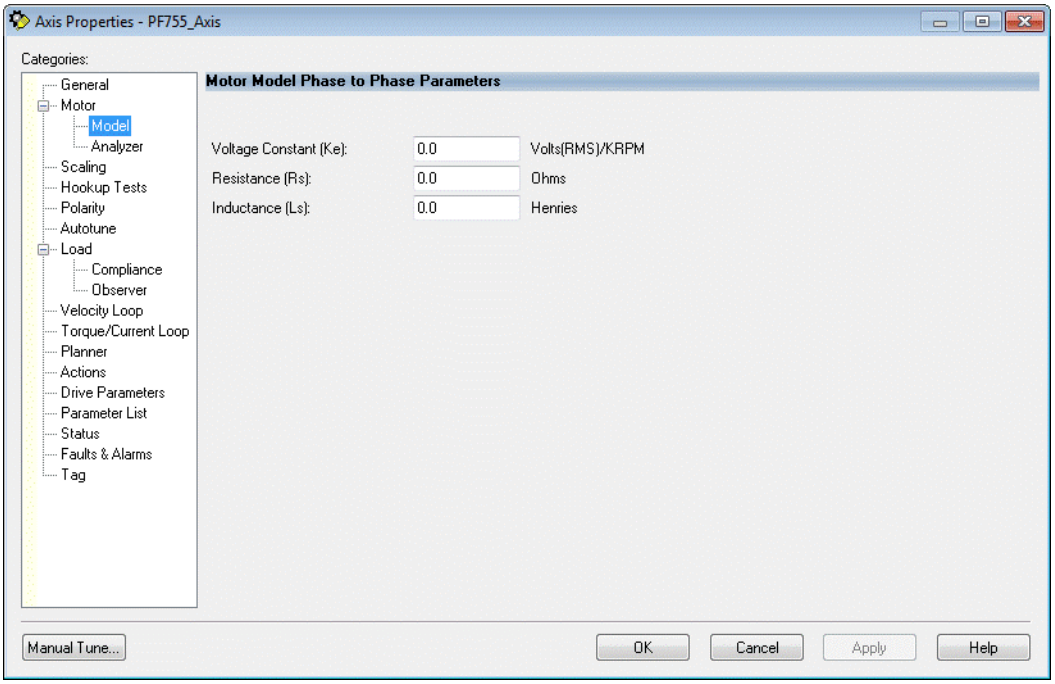
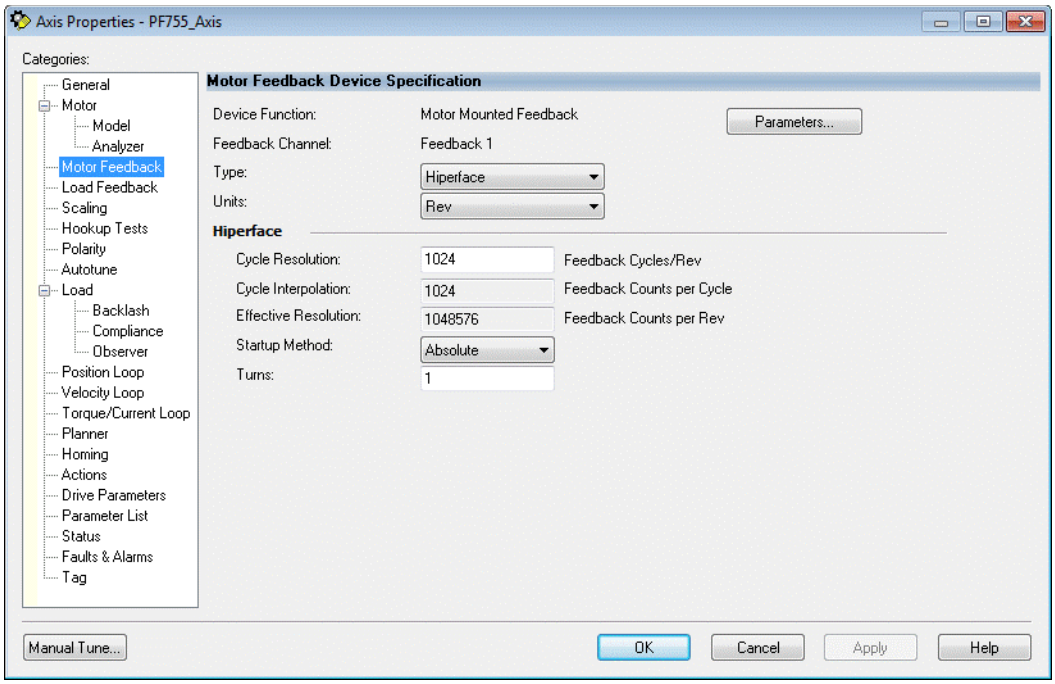


Table 16 - Permanent Magnet Motor Model Instance to Parameter Cross Reference

Integrated Motion on EtherNet/IP Instance	Drive Parameter
PM Motor Rotary Voltage Constant	P86 [PM CEMF Voltage]
PM Motor Resistance	P87 [PM IR Voltage]
PM Motor Inductance	P88 [PM IXq Voltage] P89 [PM IXd Voltage]

Motor Feedback Axis Properties Configuration

Motor Feedback Axis Properties



Motor Feedback Motion Axis Parameters

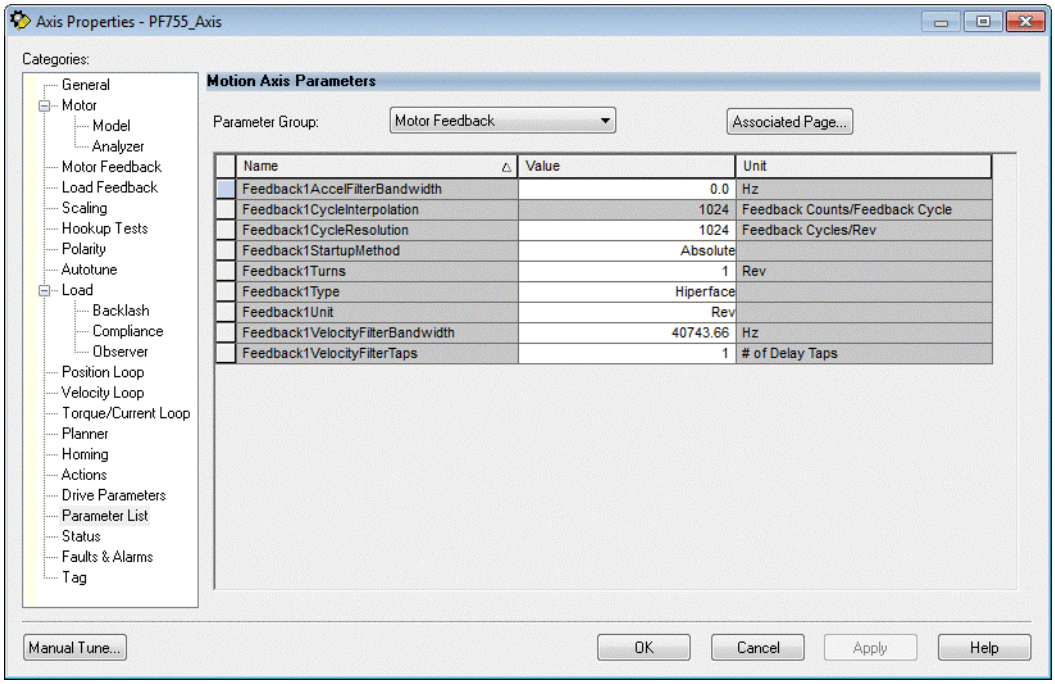
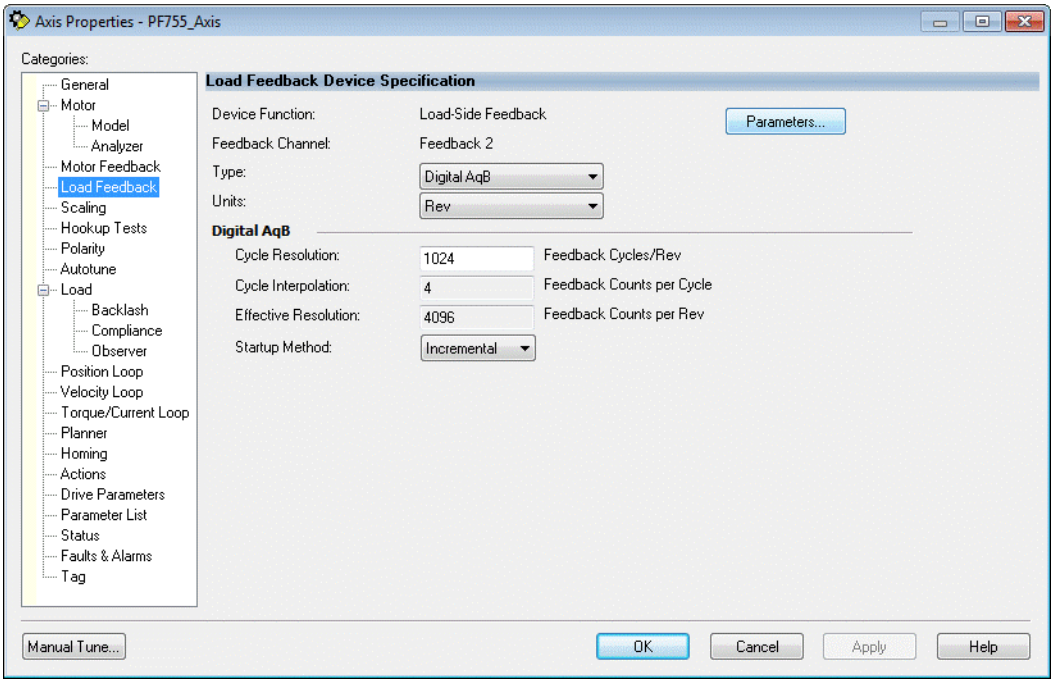


Table 17 - Motor Feedback Instance to Parameter Cross Reference

Integrated Motion on EtherNet/IP Instance	Drive Parameter
Feedback n Accel Filter Bandwidth	P705 [Inertia Adapt BW]
Feedback n Cycle Resolution	ENC: P02 [Encoder PPR] DENC: P02 [Encoder 0 PPR] DENC: P12 [Encoder 1 PPR] UFB: P15 [FB0 IncAndSC PPR] UFB: P45 [FB1 IncAndSC PPR]
Feedback n Turns	UFB: P22 [FB0 SSI Turns] UFB: P52 [FB1 SSI Turns]
Feedback n Type	UFB: P06 [FB0 Device Sel] UFB: P36 [FB1 Device Sel]
Feedback n Velocity Filter Bandwidth	P639 [SReg FB Fltr BW]
Feedback n Velocity Filter Taps	P126 [Pri Vel FdbkFltr

Motor Load Feedback Axis Properties Configuration

Motor Load Feedback Axis Properties



Motor Load Feedback Motion Axis Parameters

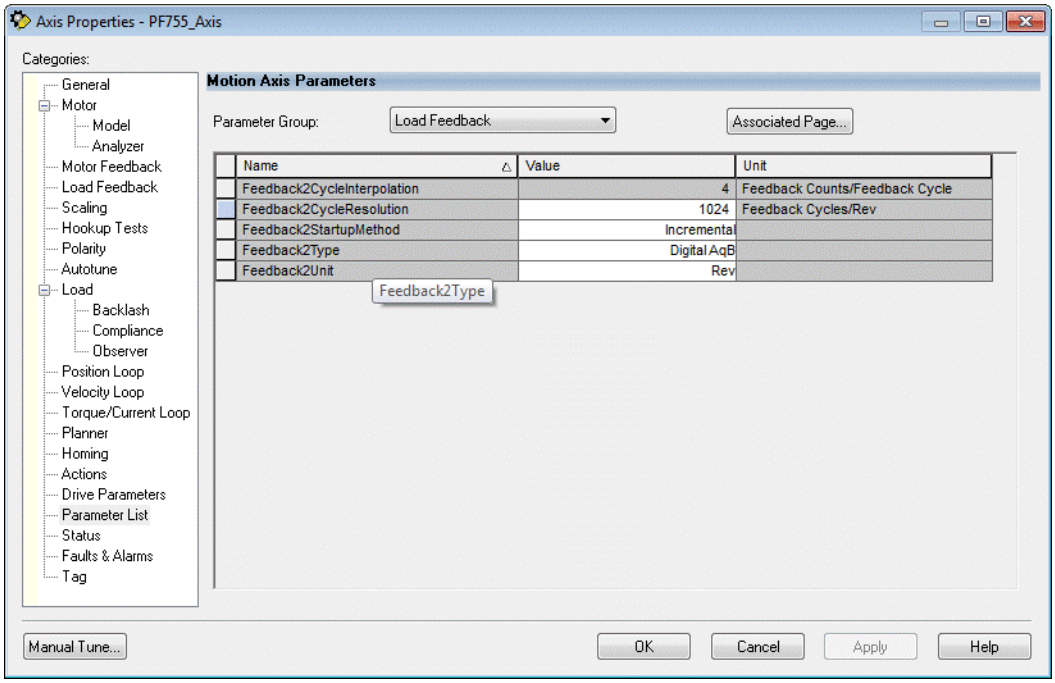
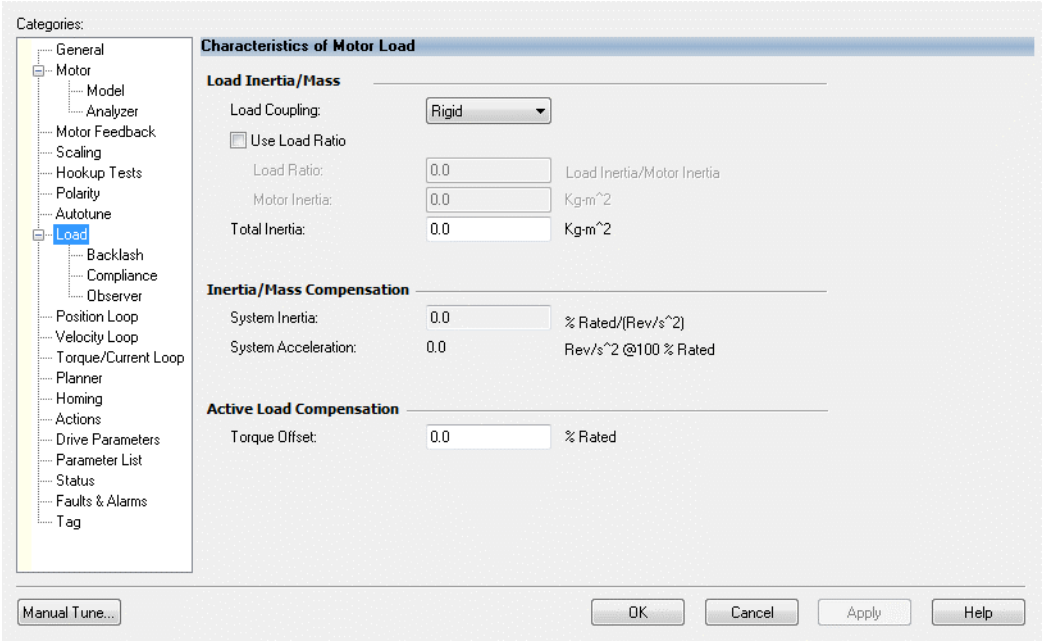


Table 18 - Motor Load Feedback Instance to Parameter Cross Reference

Integrated Motion on EtherNet/IP Instance	Drive Parameter
Feedback n Cycle Resolution	ENC: P02 [Encoder PPR] DENC: P02 [Encoder 0 PPR] DENC: P12 [Encoder 1 PPR] UFB: P15 [FB0 IncAndSC PPR] UFB: P45 [FB1 IncAndSC PPR]

Load Axis Properties Configuration

Load Axis Properties



Load Motion Axis Parameters

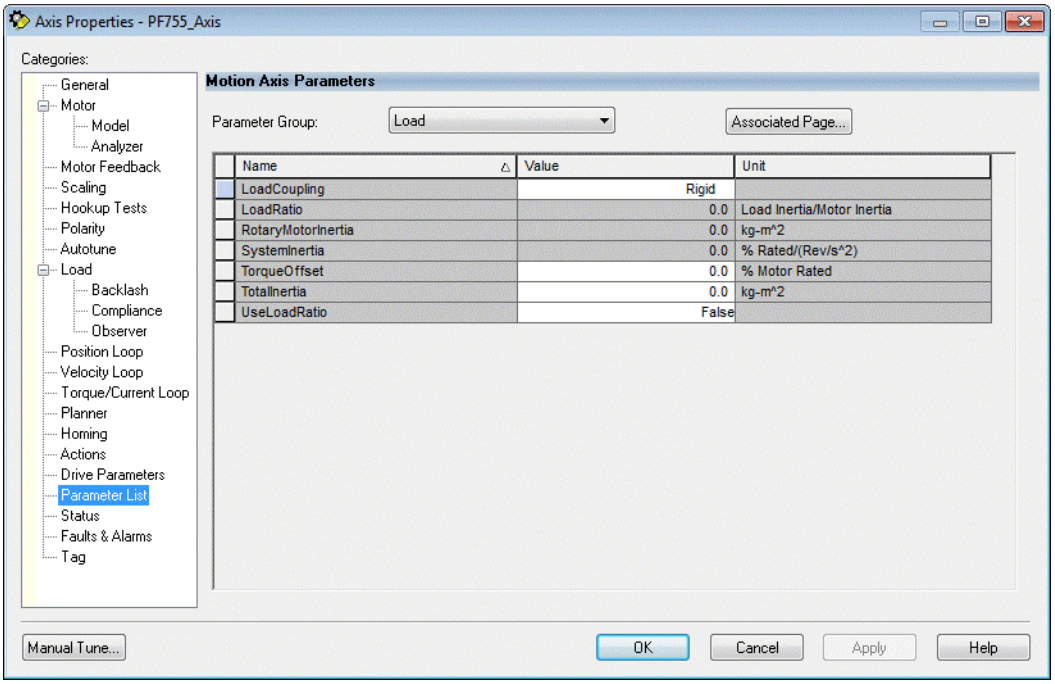
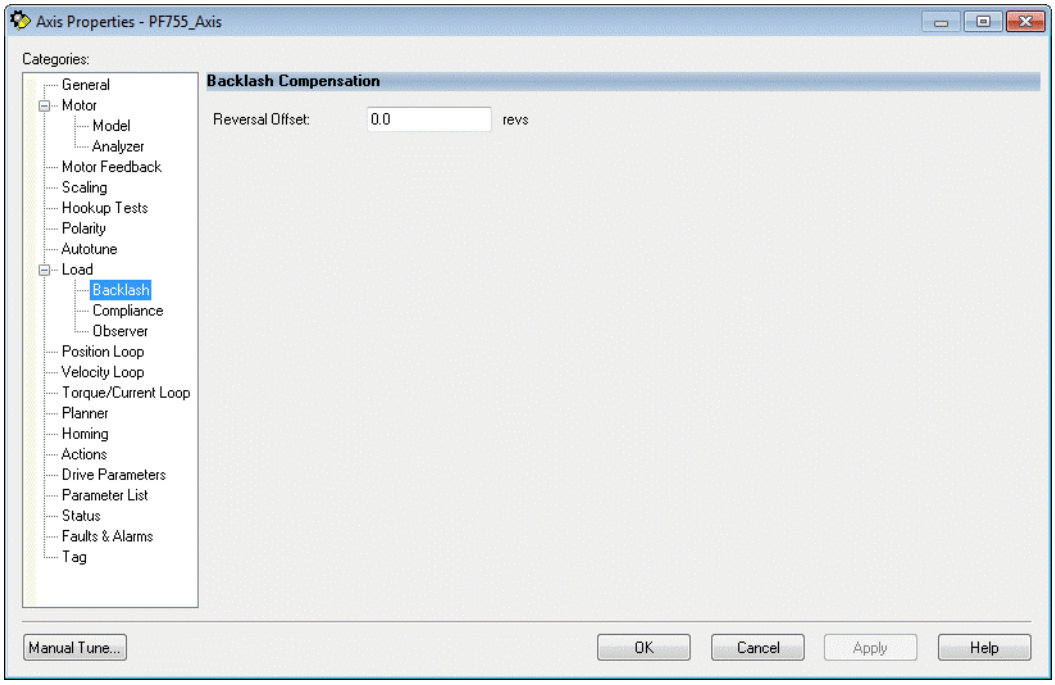


Table 19 - Load Instance to Parameter Cross Reference

Integrated Motion on EtherNet/IP Instance	Drive Parameter
Total Inertia	P76 [Total Inertia]
Torque Offset + Torque Trim	P686 [Torque Step] • Torque Offset is summed together with the Torque Trim value, which is sent synchronously to the drive every Coarse Update Period. The Torque Trim value is available for real time "active" torque corrections and the Torque Offset value is available for constant system torque compensation.

Load Backlash Axis Properties Configuration

Load Backlash Axis Properties



- Reversal Offset resides in the controller's Motion Planner

Load Compliance Motion Axis Parameters

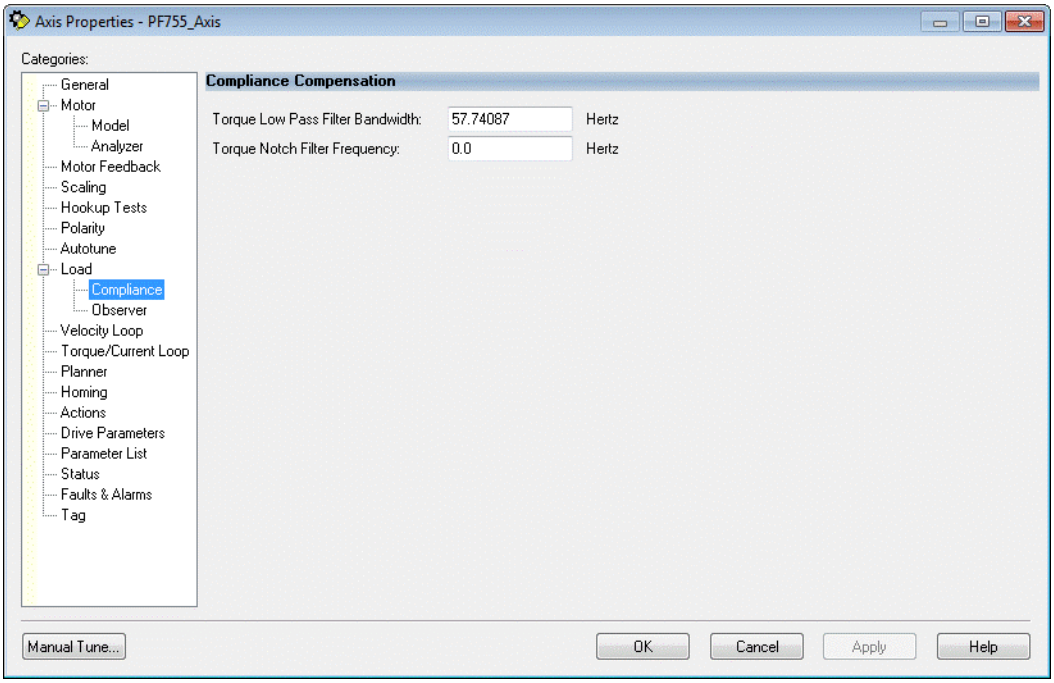
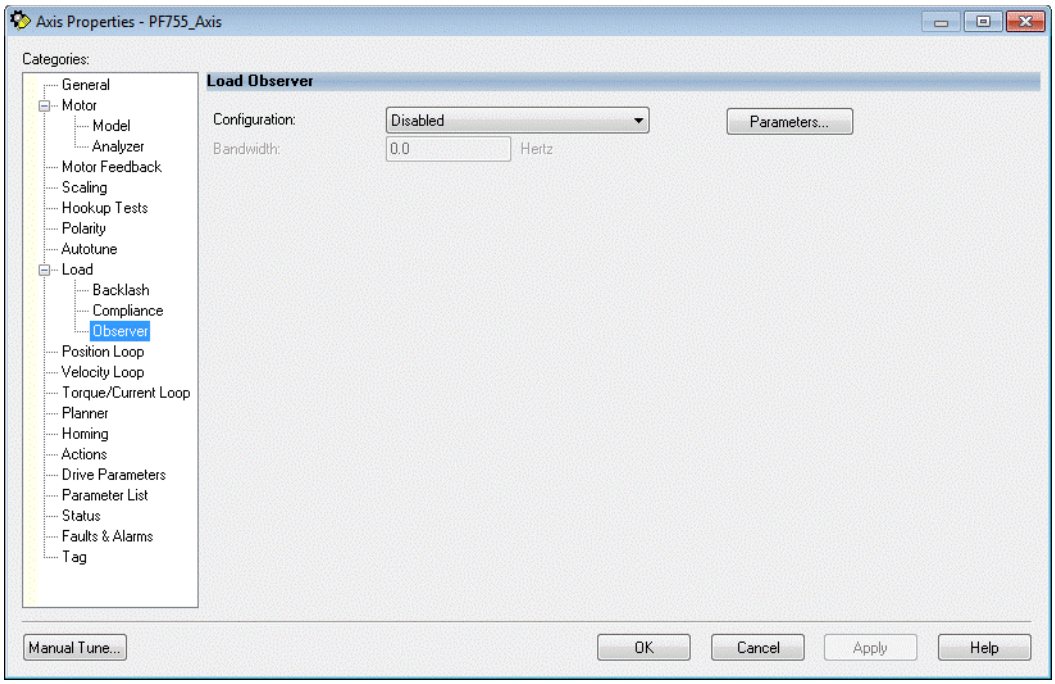


Table 20 - Load Compliance Instance to Parameter Cross Reference

Integrated Motion on EtherNet/IP Instance	Drive Parameter
Torque Low Pass Filter Bandwidth	P659 [SReg OutfltrGain]
Torque Notch Filter Frequency	P687 [Notch Fltr Freq]

Load Observer Axis Properties Configuration

Load Observer Axis Properties



Load Observer Motion Axis Parameters

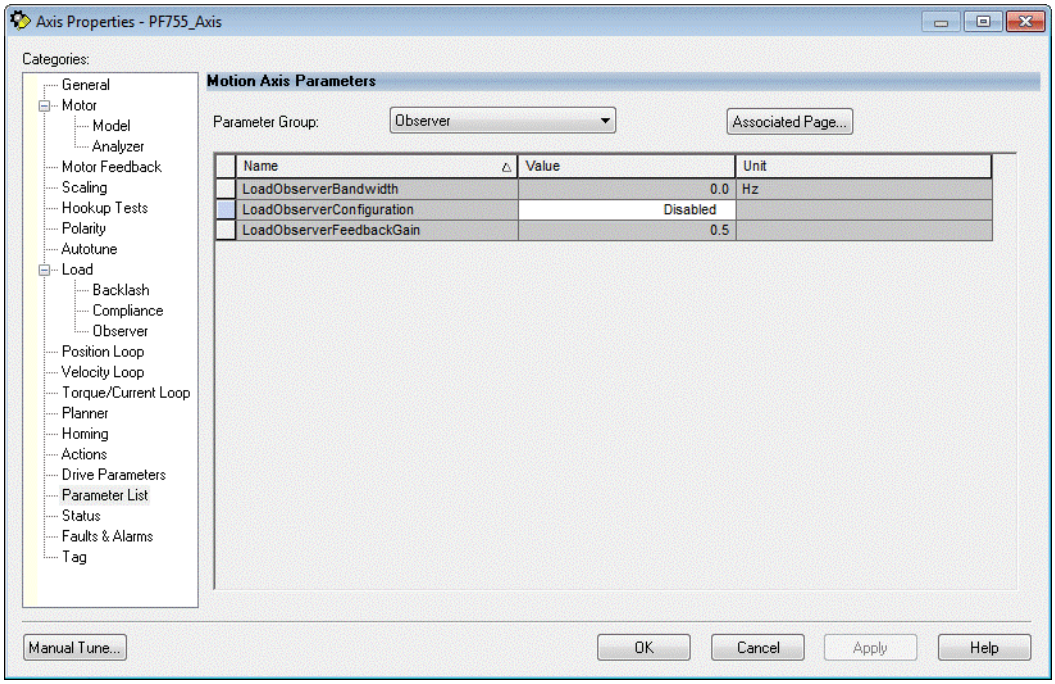


Table 21 - Load Observer Instance to Parameter Cross Reference

Integrated Motion on EtherNet/IP Instance	Drive Parameter
Load Observer Bandwidth	P711 [Load Observer BW]
Load Observer Configuration	P704 [InAdp LdObs Mode]
Load Observer Feedback Gain	P706 [InertiaAdaptGain]

Module Properties Power Tab Configuration

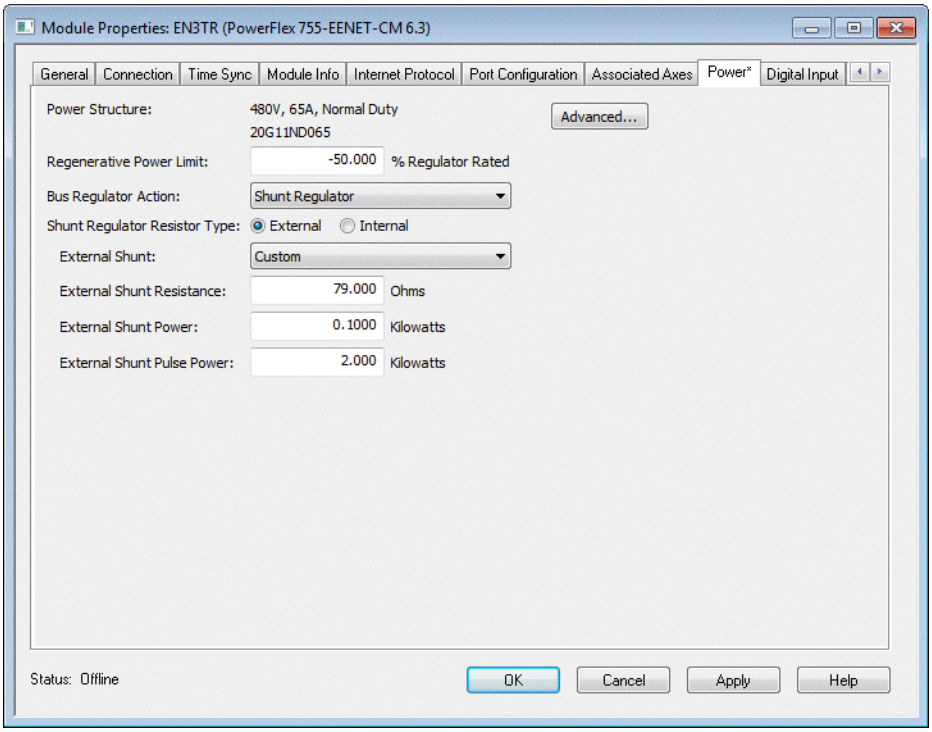


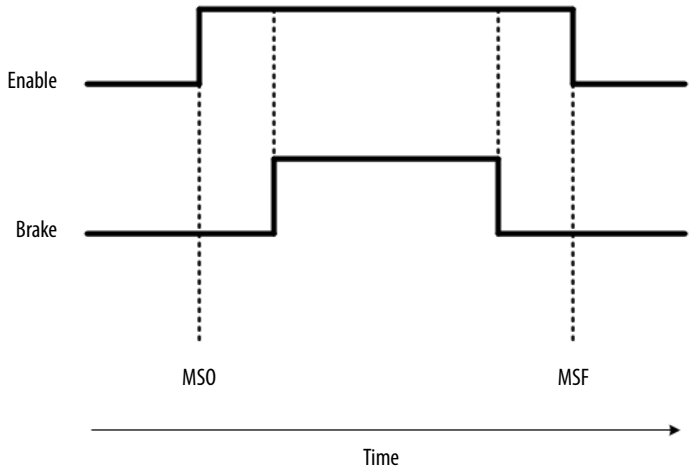
Table 22 - Power Tab to Parameter Cross Reference

Integrated Motion on EtherNet/IP Instance	Drive Parameter
Regenerative Power Limit	P426 [Regen Power Lmt]
Bus Regulator Action	P372 [Bus Reg Mode A]
Shunt Regulator Resistor Type	P382 [DB Resistor Type]
External Shunt Resistance	P383 [DB Ext Ohms]
External Shunt Power	P384 [DB Ext Watts]
External Shunt Pulse Power	P385 [DB ExtPulseWatts]

Motor Brake Control

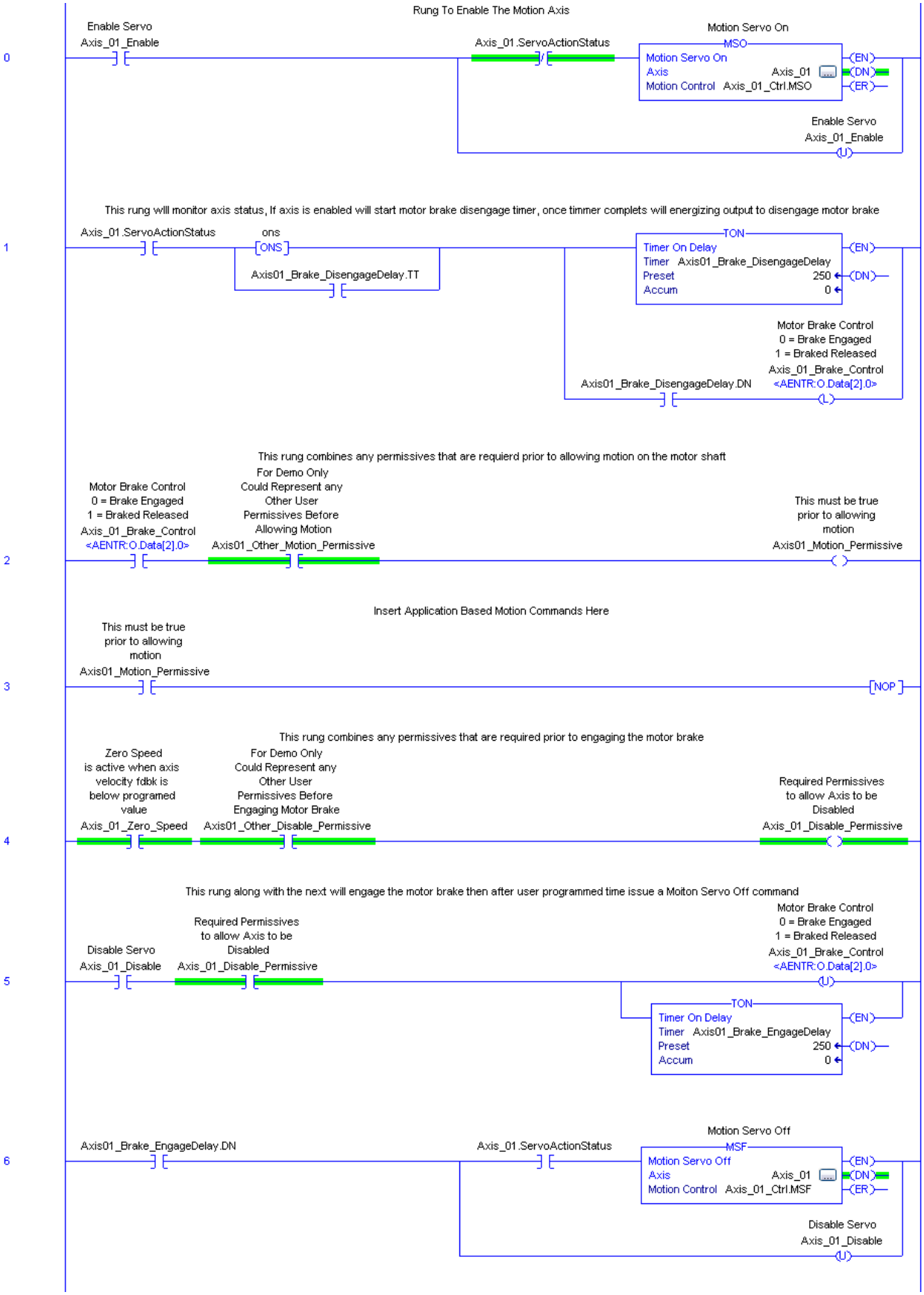
When a PowerFlex 755 drive is configured for Integrated Motion on the EtherNet/IP Network none of the I/O option modules are supported. Normal means of having the drive control the brake and utilizing drive's I/O are not supported. Motor brake control must be user-configured in the Logix controller. The basic functionality involved is to enable the drive using an MSO instruction, verify that the drive is enabled, and then apply power to disengage the motor brake. The specific motor used and the application will often dictate a time delay between when the drive is enabled and the brake is disengaged. A very similar sequence is followed with disabling the drive using an MSF instruction. In this case the brake would be engaged, and after user-configured amount of time, the drive would be disabled. Figure 25 depicts this operation.

Figure 25 - Timing Diagram

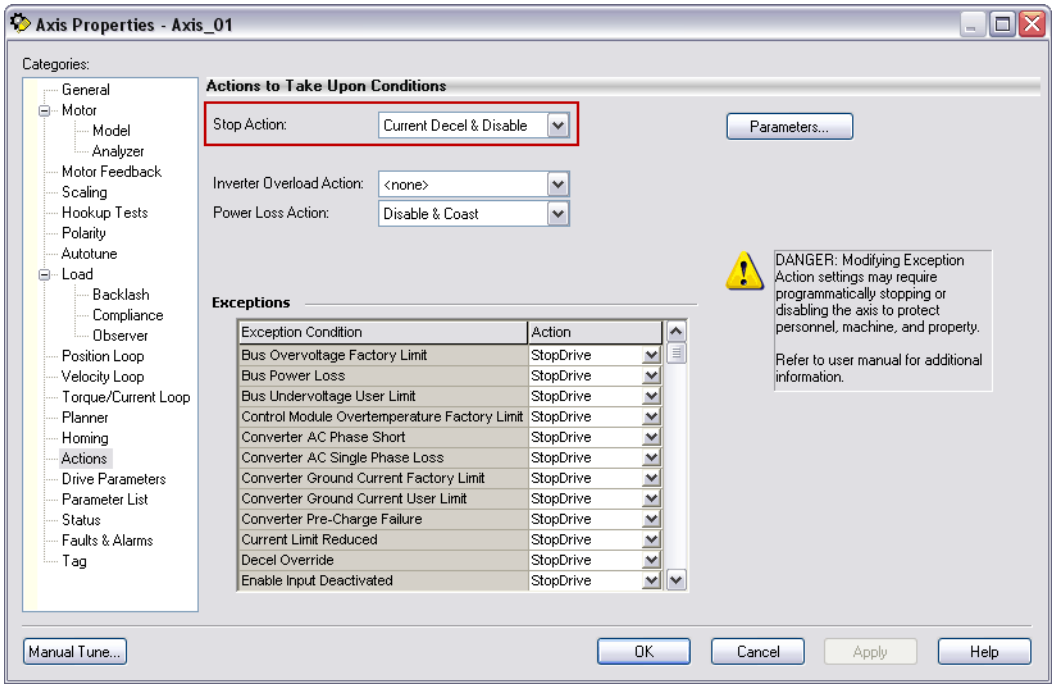


The sample ladder logic code in Figure 26 on page 253 depicts a possible solution for performing brake control (the code is an example only and is not the only solution for performing brake control). Each individual application will determine the requirements for the necessary brake control.

Figure 26 - Sample Motor Brake Code



Along with normal modes of machine operation it is important to engage the brake in the event of a fault. Fault status can be monitored in the Logix code and the brake can be engaged in the event of a fault. Knowing what the configured Stop Action is will help determine when to engage the brake in the event of a fault. Application considerations can also be factored into this decision. This stop action is configured on the Axis Properties / Actions screen (as shown in this example).

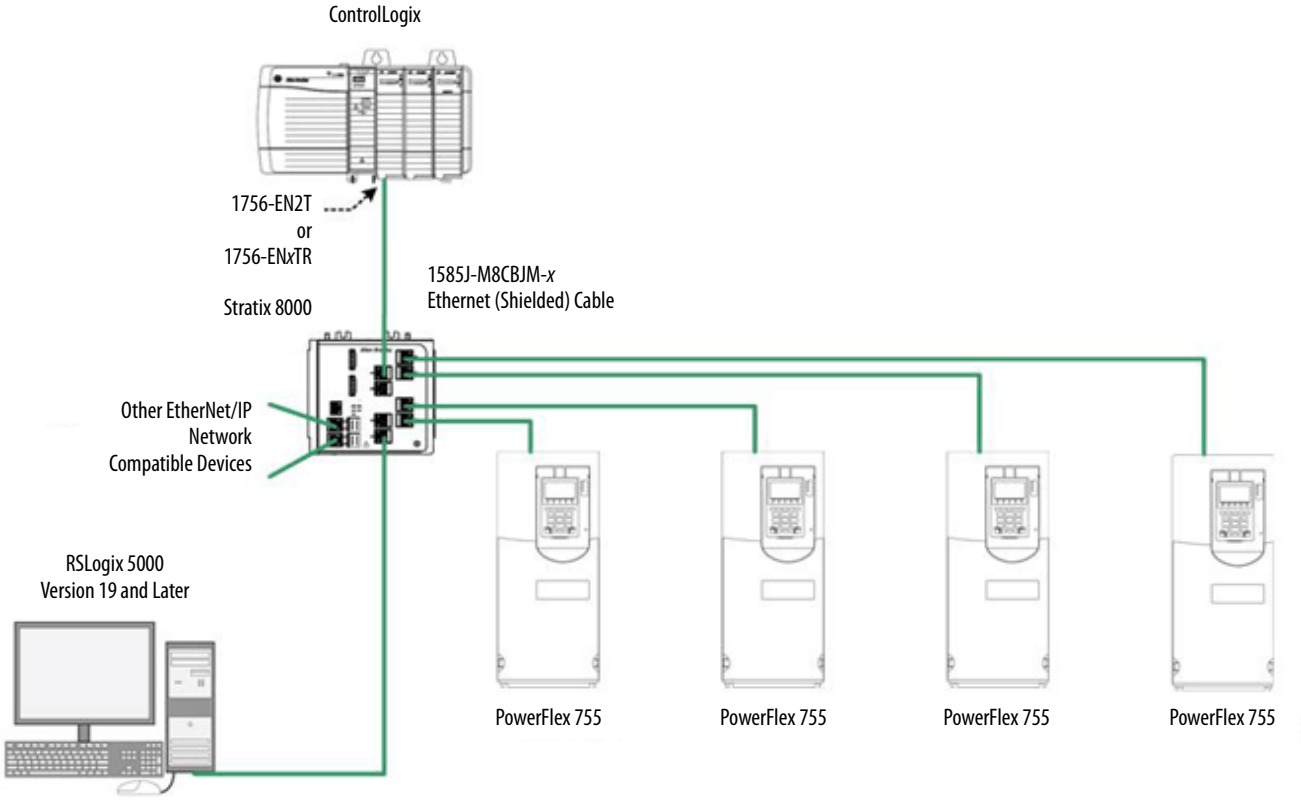


Network Topologies

This topic provides examples of network topologies that can be used when implementing an Integrated Motion on EtherNet/IP Network application.

Star Topology

A switch-level star configuration is a traditional Ethernet network layout where devices are connected to a centralized network switch, point-to-point. The star configuration is most effective when the devices are located near a centrally located network switch. In a star network topology, all traffic that traverses the network (that is, device-to-device) must pass through the central switch.



It is recommended that a managed switch with a transparent and/or boundary clock, plus QoS and IGMP protocol support be used for this Network topology.

Although the ControlLogix is illustrated, the CompactLogix controller could also be used.

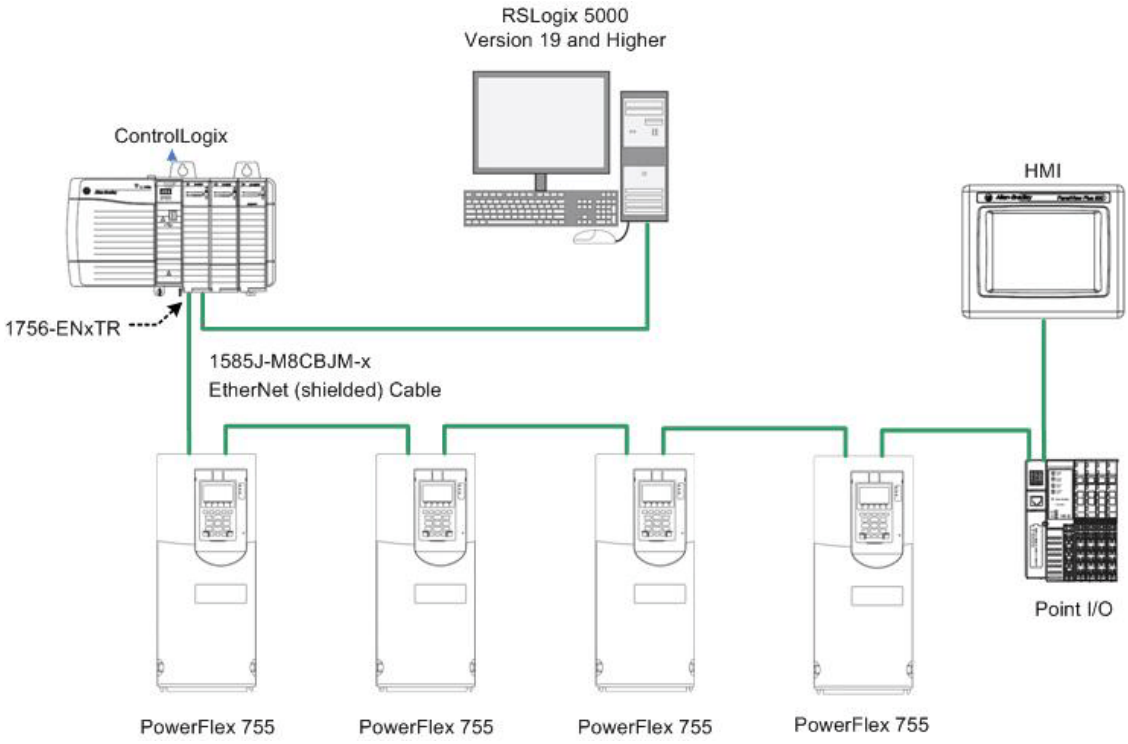
Advantages/Disadvantages

The advantage of a star network is that if a point-to-point connection is lost to an end device, the rest of the network will remain operational.

The primary disadvantage of a star topology is that all end devices must typically be connected back to a central location, which increases the amount of cable infrastructure that is required and also increases the number of available ports required by the central switch leading to a higher cost per node solution.

Linear Topology

In a linear topology, the devices are linked together via a two port embedded switch or through an EtherNet/IP network tap (1783-ETAP), instead of being connected back to a centralized network switch.



Either a Dual Port EtherNet/IP Option Module or an EtherNet/IP network tap (1783-ETAP) would be required for this network topology (this diagram illustrates an application using the dual port option card). For more information about applying a Dual Port EtherNet/IP Option Module, see the PowerFlex 20-750-ENETR Dual-Port EtherNet/IP Option Module User Manual, publication 750COM-UM008.

Although the ControlLogix controller is illustrated, the CompactLogix controller could also be used.

Advantages/Disadvantages

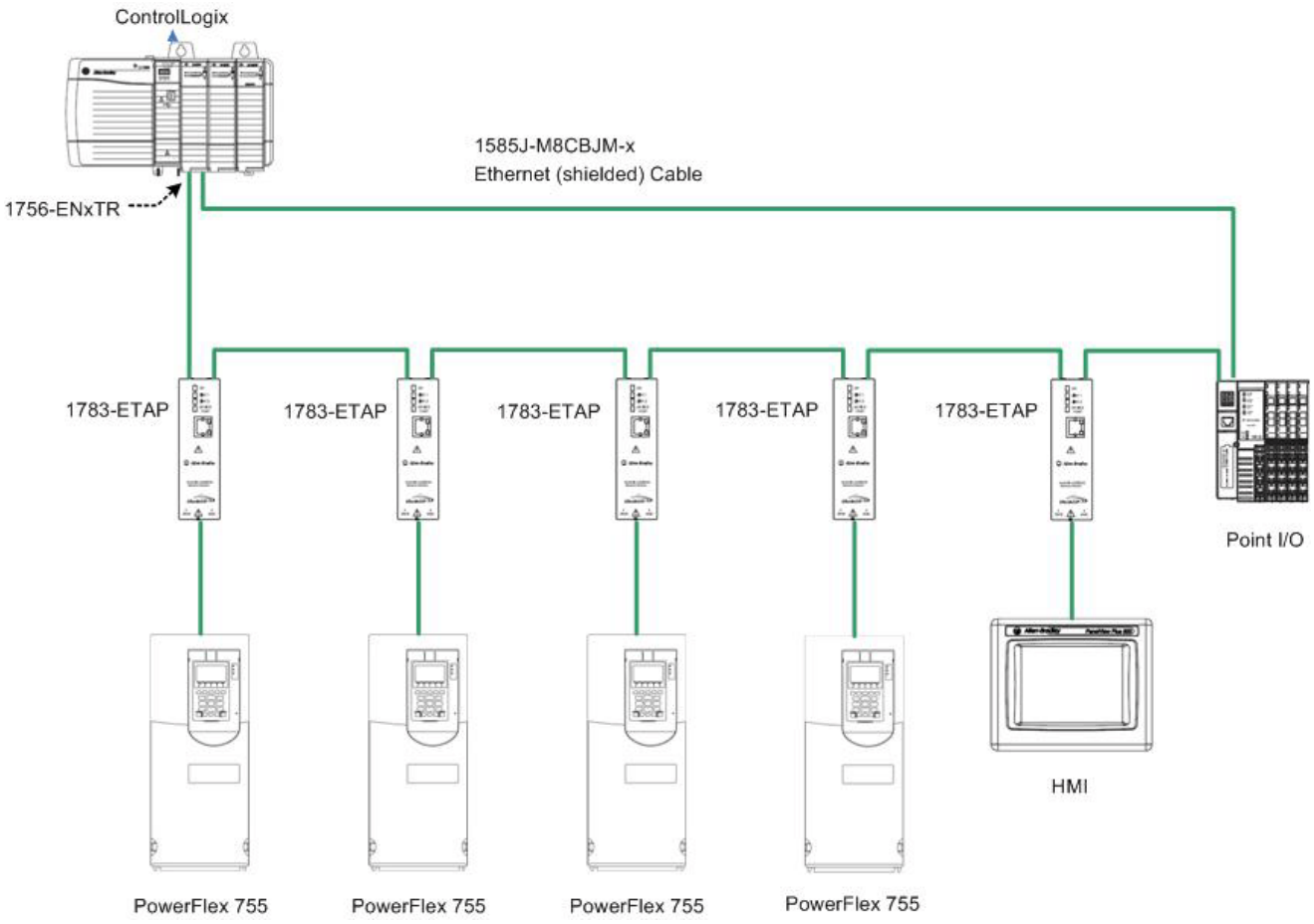
The advantages of a linear network include the following:

- The topology simplifies installation by eliminating long cable runs back to a centralized switch.
- The network can be extended over a longer distance since individual cable segments can be up to 100m.
- The network supports up to 50 mixed devices per line.

The primary disadvantage of a linear topology is that a connection loss or link failure will disconnect all downstream devices as well. To counter this disadvantage a ring topology could be employed.

Ring Topology

A ring topology, or device-level ring (DLR), is implemented in a similar fashion to linear topology. However, an extra connection is made from the last device on the line to the first, closing the loop or ring. It is crucial to configure the Ring Supervisor before connecting your linear topology into a ring topology.



Either a Dual Port EtherNet/IP Option Module or an Ethernet/IP network tap (1783-ETAP) would be required for this network topology (this diagram illustrates an application using ETAPs). For more information about applying a Dual Port EtherNet/IP Option Module, see the PowerFlex 20-750-ENETR Dual-Port EtherNet/IP Option Module User Manual, publication 750COM-UM008.

Although the ControlLogix is illustrated, the CompactLogix controller could also be used.

Advantages/Disadvantages

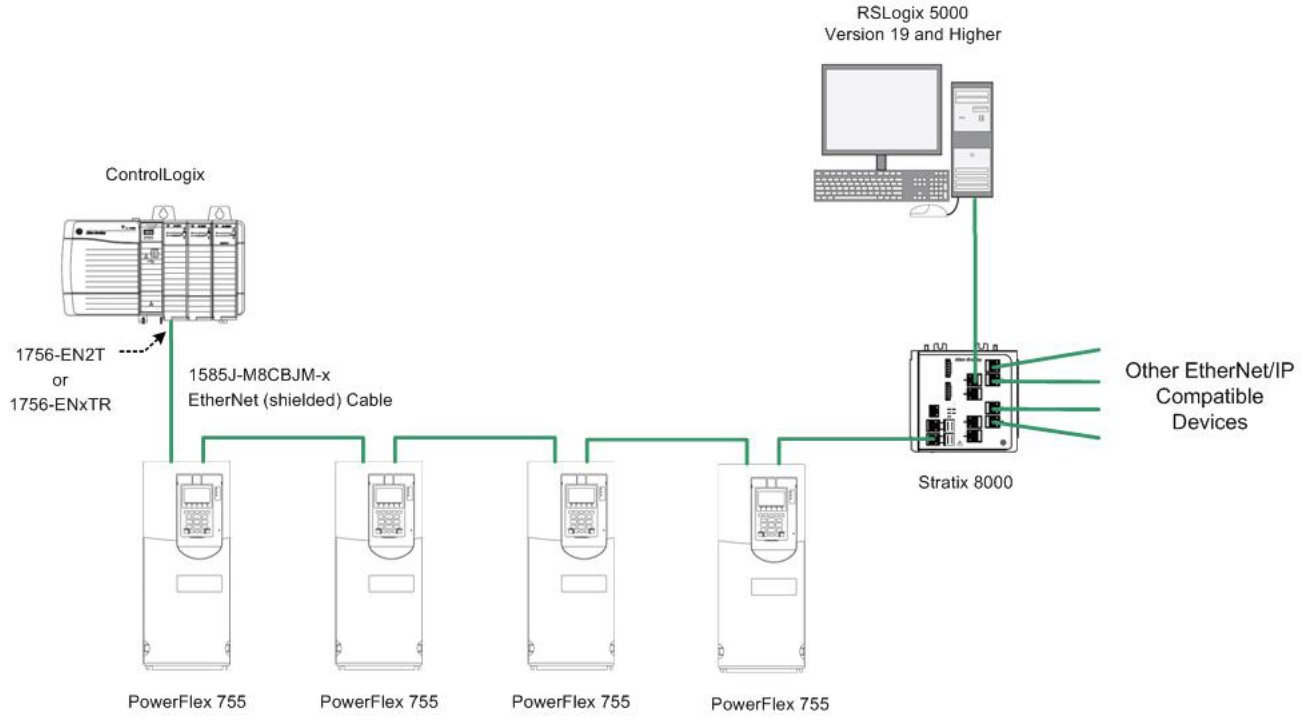
The advantages of a ring network include the following:

- Simple installation
- Resilience to a single point of failure (cable break or device failure)
- Fast recover time from a single point of failure

The primary disadvantage of a ring topology is an additional setup (for example, active ring supervisor) as compared to a linear or star network topology.

Linear/Star Topology

Network switches can be added to the end of the line, creating a linear/star topology. Ethernet devices that do not have embedded switch technology can be connected in a star topology off of the switch.

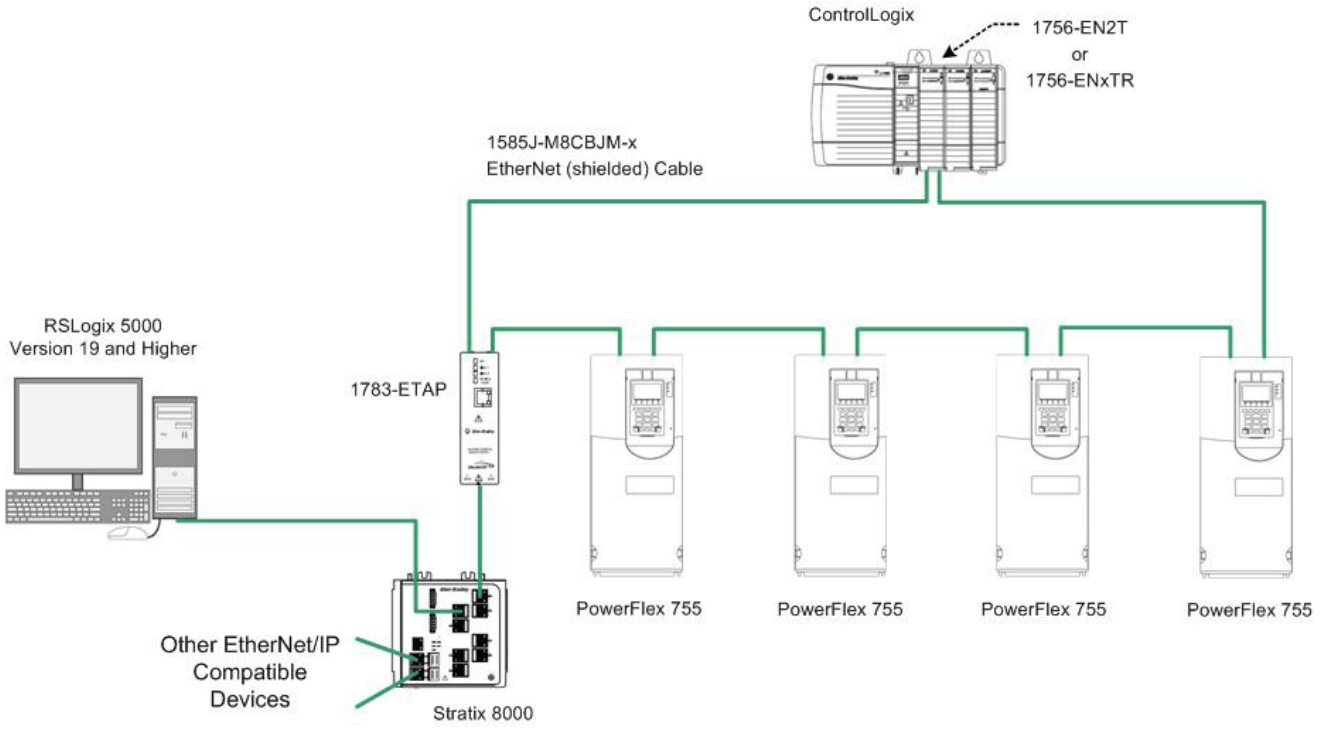


It is recommended that a managed switch with a transparent and/or boundary clock, plus QoS and IGMP protocol support be used for this Network topology.

Although the ControlLogix controller is illustrated, the CompactLogix controller could also be used.

Ring/Star Topology

Network switches can also be connected into a DLR via an Ethernet/IP tap, creating a ring/star topology.



It is recommended that a managed switch with a transparent and/or boundary clock, plus QoS and IGMP protocol support be used for this Network topology.

Although the ControlLogix controlloer is illustrated, the CompactLogix controller could also be used.

PowerFlex 755 and Kinetix 7000 Drive Overload Rating Comparison for Permanent Magnet Motor Operation

The PowerFlex 755 drive can be configured for a normal duty or heavy duty operation. The heavy duty rating has a lower continuous current rating and therefore can produce more current during an overload.

Duty Rating	0 Hz	100%	110%	150%	180%
Normal	50%	100%	One minute	3 seconds	Not applicable
Heavy	65%	75% of normal duty	–	One minute of normal duty	3 seconds of normal duty

The Kinetix 7000 drive overload capability is specific for each power structure. However, the Kinetix 7000 can produce 100% current at 0 Hz.

With permanent magnet motors, the torque is directly proportional to the current. Therefore, the overload ratings of the drive to which the motor is connected provides the torque overload capability of the motor.

PowerFlex 755 Drive Option Module Configuration and Restrictions

When the PowerFlex 755 drive is configured for an Integrated Motion on the EtherNet/IP Network application, only specific option modules are supported, and in some cases, the port in which the option module is installed in the control pod is restricted.

IMPORTANT The PowerFlex 750-Series I/O option modules (20-750-2262C-2R, 20-750-2263C-1R2T, 20-750-2262D-2R) must not be used with the Integrated Motion on the EtherNet/IP Network.

Supported Modules		Valid Port Installation Location
Cat. No.	Option Module Name	
20-750-S	Safe Torque Off	6
20-750-S1	Safe Speed Monitor	6
20-750-ENC	Single Incremental Encoder	4…8
20-750-DENC	Dual Incremental Encoder	4…8
20-750-UFB	Universal Feedback	4…6
20-750-APS	Auxiliary Power Supply	8
20-750-ENETR	Dual-Port Ethernet/IP	4 and 5

If an unsupported option module is installed, the drive will stop responding and the HIM will display 'CONFIGURING.'

Safety Option Modules (20-750-S, 20-750-S1)

This restriction and configuration setting must be used when using either of these safety option modules with the Integrated Motion on the EtherNet/IP Network:

- The option modules must be installed in port 6 of the drive control pod only.
- The specific drive module and option catalog number must be selected when adding the drive to the I/O tree in the project. For example, when adding a PowerFlex 755 drive with a Safe Speed Monitor option module, choose 755-EENET-CM-S1.

Feedback Option Modules (20-750-ENC, 20-750-DENC, and 20-750-UFB)

Follow the same installation and configuration instructions provided in the PowerFlex 750-Series AC Drives Installation Instructions, publication 750-IN001.

Auxiliary Power Supply Option Module (20-750-APS)

Follow the same installation and configuration instructions provided in the PowerFlex 750-Series AC Drives Installation Instructions, publication 750-IN001.

Dual-Port EtherNet/IP Option Module (20-750-ENETR)

Follow the same installation and configuration instructions provided in the PowerFlex 750-Series AC Drives Installation Instructions, publication 750-IN001.

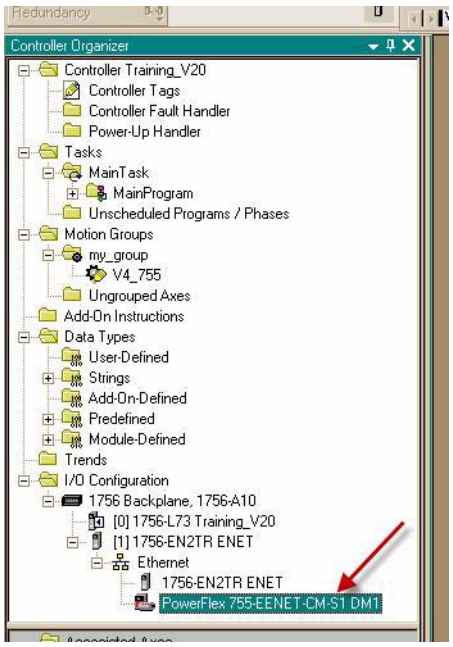
Regenerative/Braking Resistor

When using a PowerFlex 755 drive with a dynamic brake (shunt regulator) in an Integrated Motion on the Ethernet/IP network the dynamic brake must be set up as part of the I/O connection of the PowerFlex 755 embedded Ethernet/IP module (EENET-CM-*xx*) properties. Failure to set up the dynamic brake correctly could lead to mechanical damage of the machine. Dynamic brake (shunt) resistor sizing is not covered in this document. For more information on resistor sizing, see the Drives Engineering Handbook, publication DEH-1300-10.

I/O Configuration for a Dynamic Brake (shunt regulator)

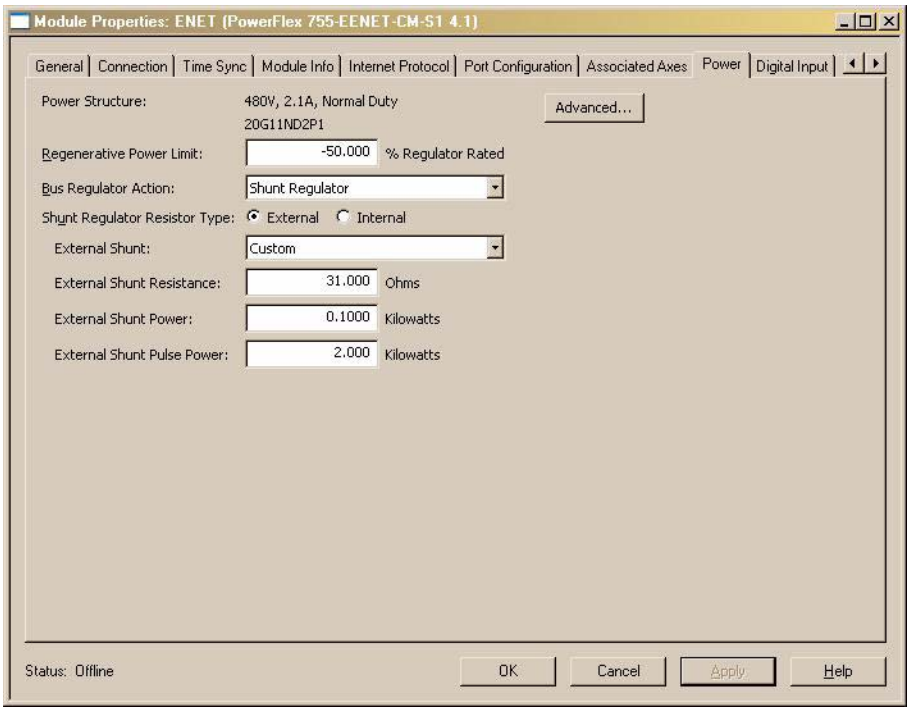
Follow these steps to configure a dynamic brake (shunt regulator) for a PowerFlex 755 drive in RSLogix 5000.

1. In the I/O Configuration, double-click the PowerFlex 755-EENET-CM-*xx* module and select Properties.



The Module Properties dialog box appears.

2. Click the Power tab and configure the appropriate boxes according to your application.



Regenerative Power Limit	The amount of energy that the drive will allow during regeneration. If an external regenerative power supply or shunt (dynamic brake) resistor is used, it is recommended that this value be set to -200.0%. **Important:** If this value is set too low, the ability of the drive to stop a motor will be limited.
Bus Regulator Action	• Disabled - This selection disables the drive's internal DC bus voltage regulation feature. Select this option if there is an external regenerative brake or regenerative line supply connected to the drive DC bus. • Shunt Regulator - This selection is used when either an external shunt resistor is connected to the drive or the internal IGBT will be controlling the power dissipation to the resistor (the type of shunt resistor is selected below). • Adjustable Frequency - This selection allows the drive to either change the torque limits or ramp rate of the velocity to control the DC bus voltage. This option is not recommended for positioning applications because it will override the velocity and the system will overshoot or may not stop. • Shunt then Adjustable Frequency - This selection allows the Shunt resistor to absorb as much energy as it is designed for, then transitions to adjustable frequency control if the limit of the resistor has been reached. • Adjustable Frequency then Shunt - This selection allows for adjustable frequency control of the DC bus. If adjustable frequency control cannot maintain the DC bus within limits, the shunt resistor will be activated.
Shunt Regulator Resistor Type	Select the type of resistor connected to the drive. Internal resistors include 20-750-DB1-D1 or 20-750-DB1-D2 for frames 1 and 2 drives, respectively. External identifies that a user-selected resistor is used.
External Shunt	When using an external shunt resistor select "Custom."

External Shunt Resistance	Enter the resistance of the external resistor connected to the drive terminal block connections, BR1 and BR2. Verify that the resistance is equal to or greater than the minimum resistance for the drive capabilities. See "Minimum Dynamic Brake Resistance" in the PowerFlex 750-Series AC Drives Technical Data, publication 750-TD001.
External Shunt Power	Enter the continuous power dissipation rating (kW) of the external resistor. Failure to specify the correct value can cause the drive to either stop sending energy to the resistor prematurely or overheat the resistor. For example, if an 800 W rated resistor is installed, enter 0.8 in this field.
External Shunt Pulse Power	The Watt-Second or Joules rating (kW) of the resistor. This is the amount of energy that the resistor can withstand for one second to reach the maximum temperature. Failure to specify the correct value can cause the drive to either stop sending energy to the resistor prematurely or overheat the resistor.

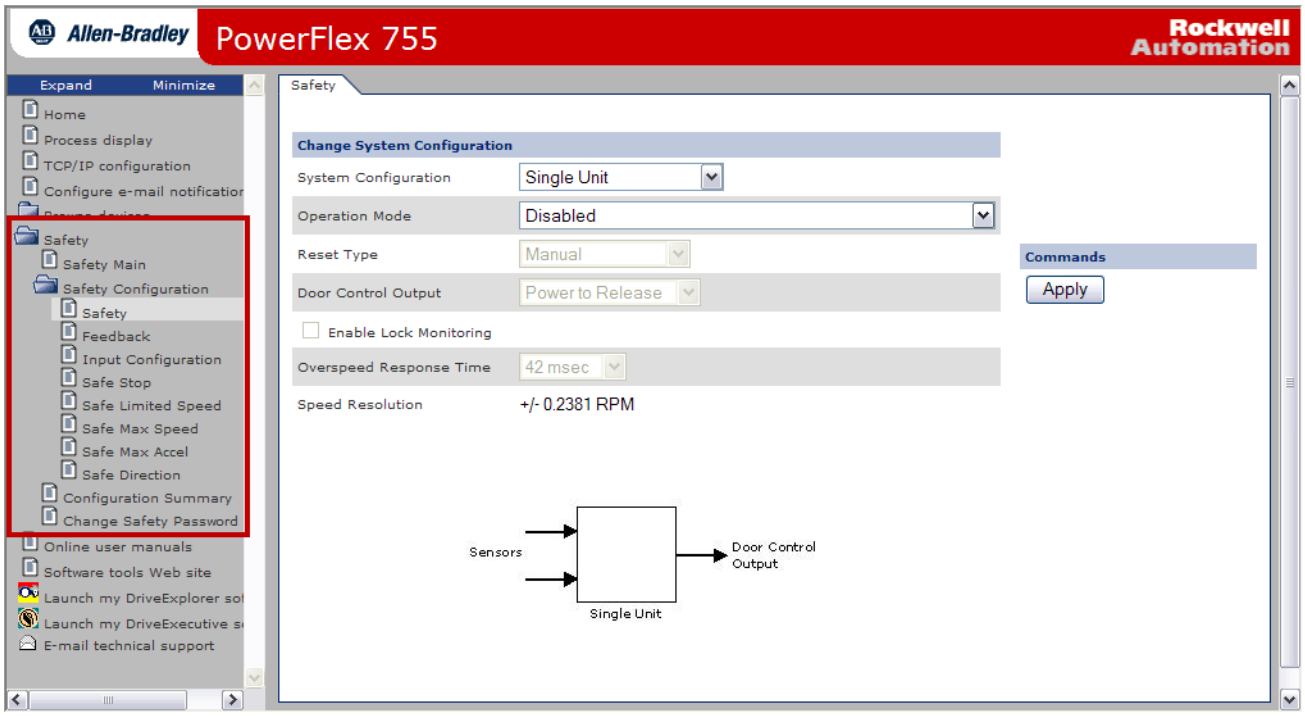
3. Click OK.

Safe Speed Monitor Option Module (20-750-S1) Configuration

When a PowerFlex 755 drive is configured for Integrated Motion on the EtherNet/IP Network the configuration of the Safe Speed Monitor functions are accomplished via a web page.

Configuring the Safe Speed Functions

The Safe Speed Monitor module web page differs from the Embedded EtherNet/IP adapter (port 13) web page that is enabled by setting adapter parameter P52 [Web Enable] to 1 “Enabled.” The Safe Speed Monitor module web page is not accessible until the drive has established a network connection to a Logix processor and the Integrated Motion on the EtherNet/IP Network connection has been established. The web page is then accessed by entering the IP address of the drive into a web browser (for example, http://192.168.1.20/). Currently, safety configuration settings cannot be saved in the drive or downloaded to other drives.

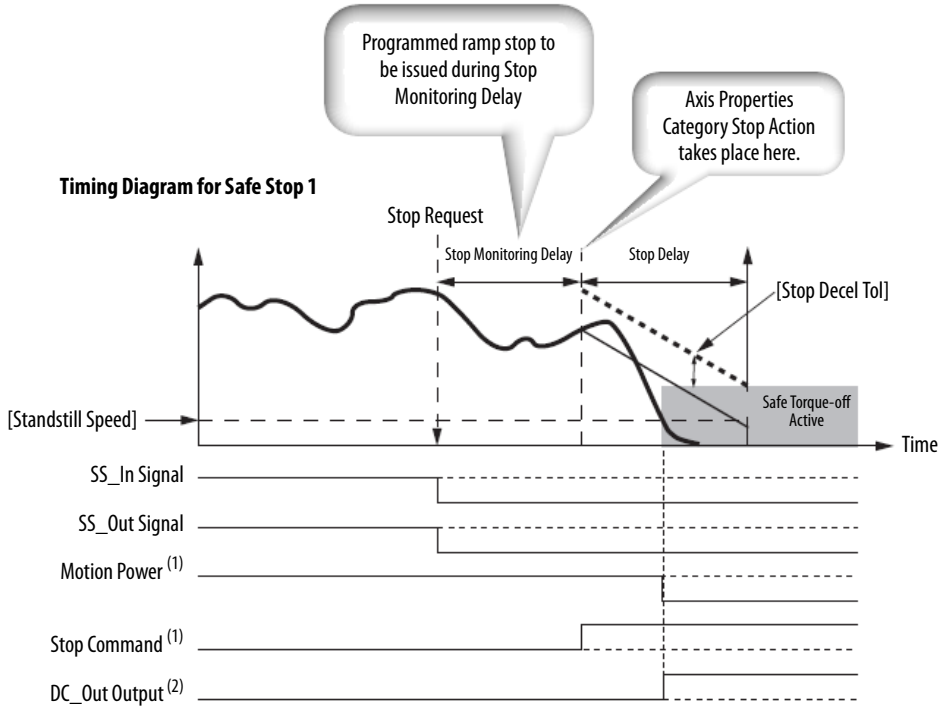


TIP The Safe Speed Monitor module parameters are not currently part of the Logix platform and therefore, are not overwritten when a drive establishes a Integrated Motion on the EtherNet/IP Network connection. Therefore, it is possible to program the Safe Speed Monitor functions with configuration software (for example, Connected Components Workbench) or a HIM before a network connection is established. This lets you save the safety configuration in the software application or HIM. Configuration of the safety functions can be accomplished in one of the following ways:

- Program the Safe Speed Monitor functions and then download the program that includes the drive parameters to the Logix controller and establish the network connection.
- Inhibit the drive in the Logix I/O tree and program the Safe Speed Monitor functions.
- Disconnect the network cable between the drive and the controller and program the Safe Speed Monitor functions.

Configuring the Stop Command

While there are different selections when operating the drive and Safe Speed Monitor option module in Standard mode versus the Integrated Motion on the EtherNet/IP Network mode, the equivalent functions operate the same. In the Integrated Motion on the EtherNet/IP Network mode of operation, the Stop Command is programmed in the Actions Category of the Module Properties dialog box. It is important to realize that there is no option to have a ramped stop selected here; only current limit and motor brake options are available. These selections do not ensure that a consistent ramp will be implemented each time. If a repeatable ramped stop is desired, then the user can program a Stop Monitor Delay as a part of the Safe Speed Monitor configuration and then monitor the Safe Speed inputs from the controller and issue a ramped stop prior to the safety core issuing the Stop Command signal (as shown in this diagram).



(1) This signal is internal between the safety option module and the drive.
(2) The DC_Out output is shown configured as Power to Release.

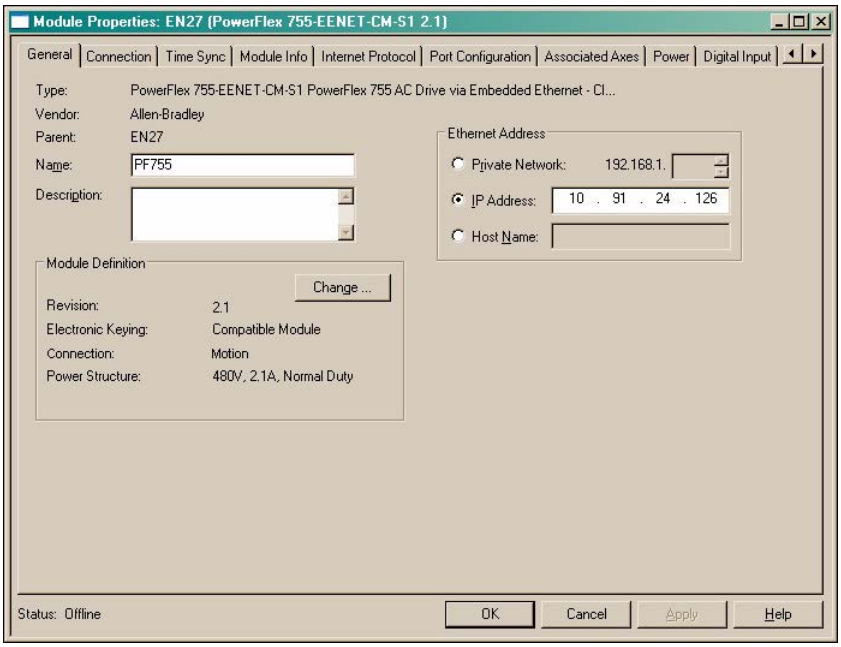
Speed Limited Adjustable Torque (SLAT)

This topic describes how to configure a PowerFlex® 755 AC drive with embedded Ethernet/IP for Speed Limited Adjustable Torque (SLAT) operation using an Integrated Motion on the Ethernet/IP network in RSLogix™ 5000 software. For more information on SLAT refer to the following publications:

- See Speed Limited Adjustable Torque (SLAT) Min Mode and SLAT Max Mode in the PowerFlex 700S AC Drives with Phase II Control Reference Manual, publication PFLEX-RM003.
- See Slat Configuration in the Integrated Motion on the Ethernet/IP Network Reference Manual, publication MOTION-RM003.

Add a PowerFlex 755 Drive Module to Your Project

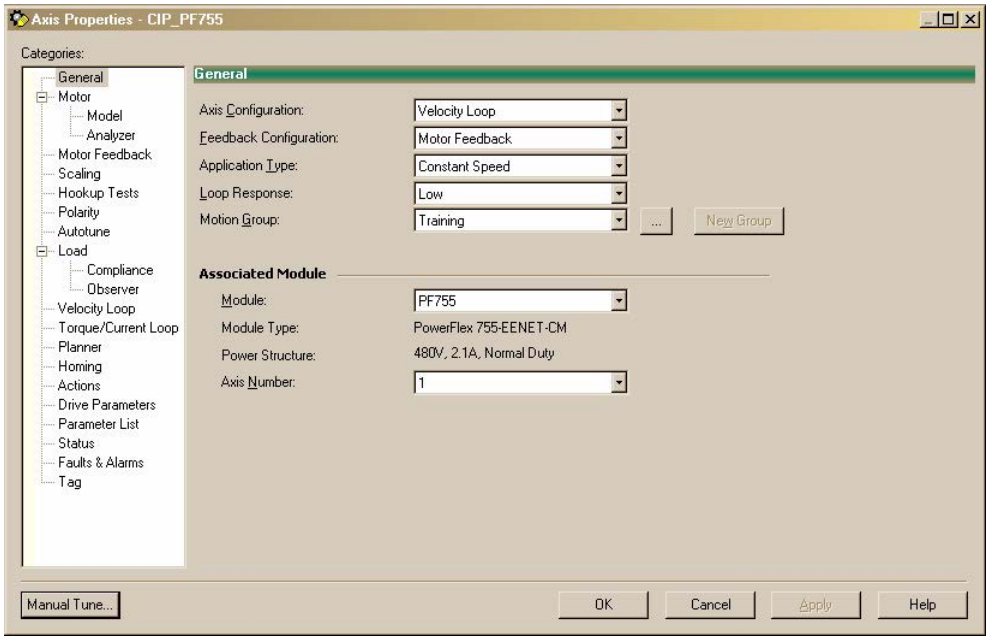
See the Integrated Motion on the Ethernet/IP Network Configuration and Startup User Manual, publication MOTION-UM003, for specific instructions on adding a PowerFlex 755 with embedded Ethernet/IP drive module to your RSLogix 5000 project. An example Module Properties dialog box for a PowerFlex 755 with embedded Ethernet/IP is shown here.



Create and Configure an Axis for the PowerFlex 755 Drive

1. See the Integrated Motion on the Ethernet/IP Network Configuration and Startup User Manual, publication MOTION-UM003, for specific instructions on creating and configuring the axis for the PowerFlex 755 drive.

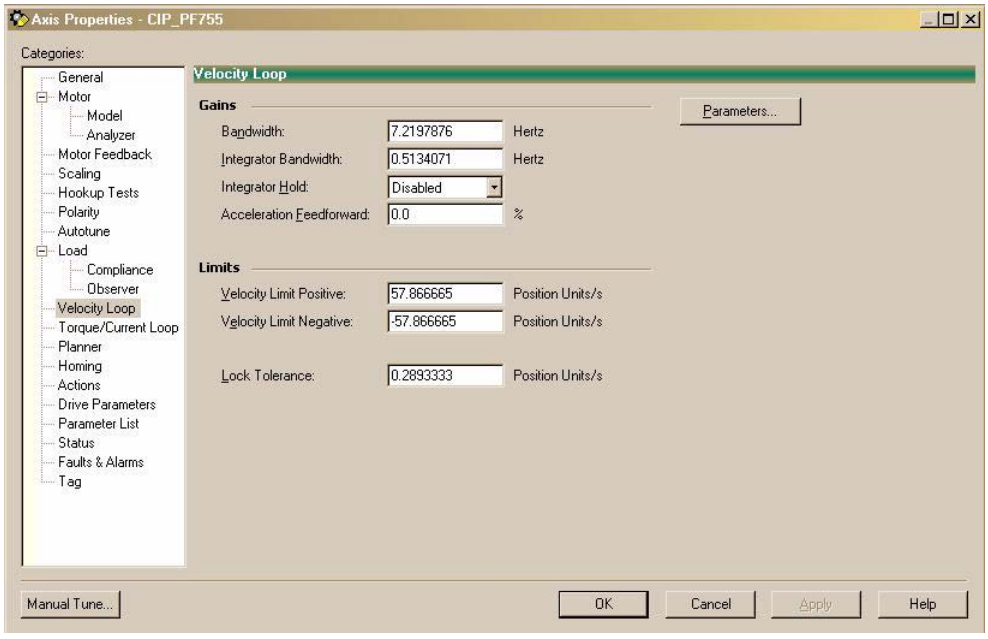
2. In the General dialog, from the Axis Configuration pull-down menu, choose Velocity Loop.



3. Select the Velocity Loop category.

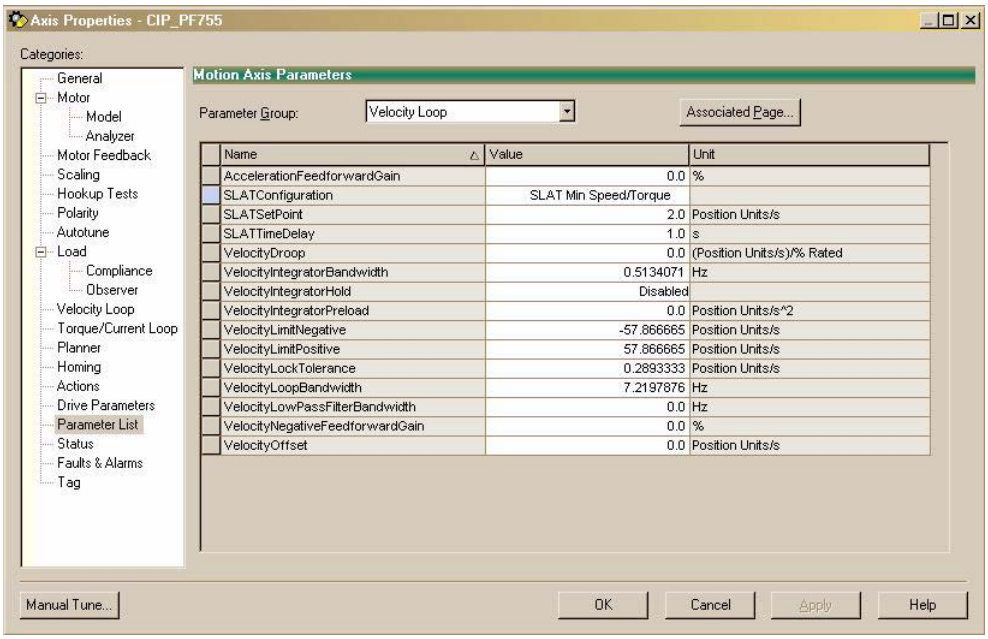
   The Velocity Loop dialog box appears.

4. Click Parameters.



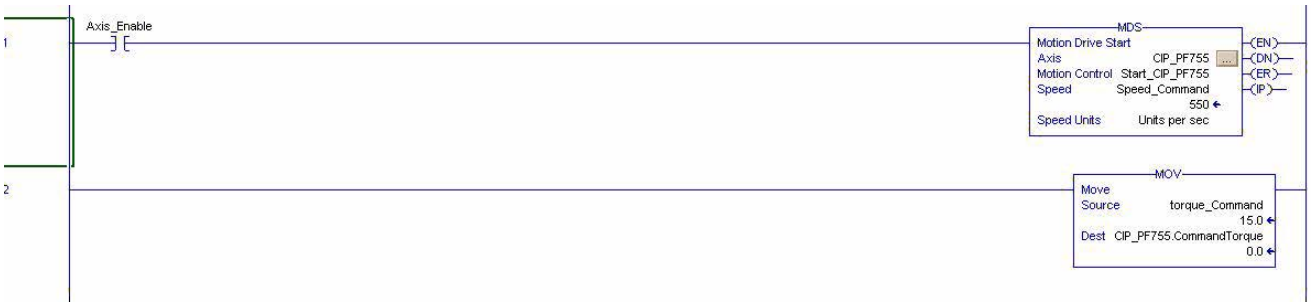
The Motion Axis Parameters dialog box appears.

5. Configure the SLAT parameters. See Slat Configuration in the Integrated Motion on the Ethernet/IP Network Reference Manual, publication MOTION-RM003, for a complete list and descriptions of the SLAT parameters.



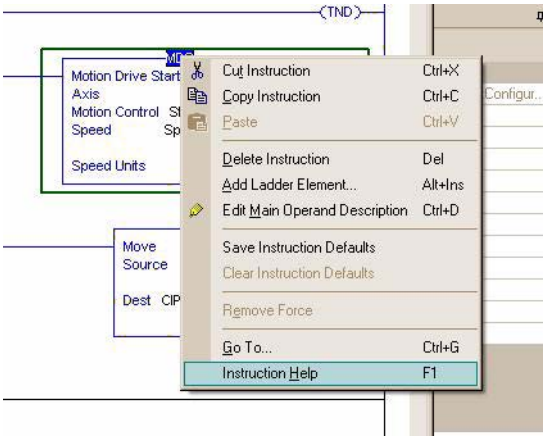
RSLogix 5000 Program Commands

When using SLAT with Integrated Motion on the Ethernet/IP network you must start the PowerFlex 755 drive with the MDS instruction as shown below. The Speed reference is sent in the MDS instruction. Also, the torque command is sent to "AxisTag.CommandTorque." To make changes to the speed reference you will need to re-trigger the MDS instruction.



To use the Motion Axis Stop (MAS) instruction, you must set Change Decel to "No." Otherwise an instruction error will occur. The deceleration rate is set based on the Ramp Deceleration attribute.

To view help for the MDS instructions, right-click MDS in the function block and choose Instruction Help, or select the instruction and press F1. Additionally, see "Speed Limited Adjustable Torque (SLAT) Min Mode and SLAT Max Mode" in the PowerFlex 700S AC Drives with Phase II Control, Reference Manual, publication PFLEX-RM003.

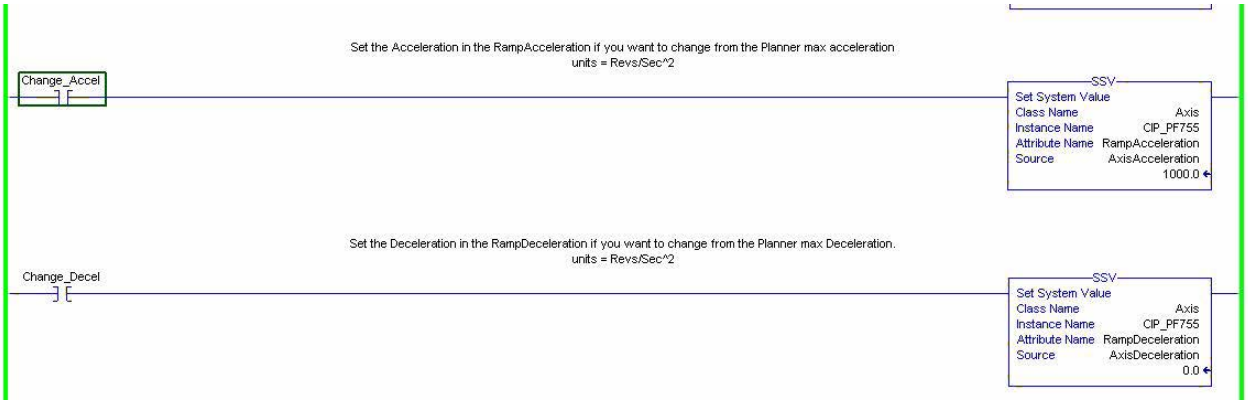


Changing the Accel/Decel Times for the MDS Instruction

If you are using the MDS instruction, the drive will accelerate and decelerate at the planner Max Acceleration and Deceleration values. To set the "RampAcceleration" and "RampDeceleration" you will need to use SSV instructions to change the ramp rates. Below is an example of the SSV instructions:

- Set the RampAcceleration / RampDeceleration attribute to "x" revs/sec^2
- Class Name = Axis
- Instance Name = "Axis Name"
- Attribute Name = RampAcceleration/RampDeceleration
- Source = Tag for value

Example: Velocity (Speed) command is 30 revs/sec and you want to reach that speed from zero in 6.5 seconds. Ramp Acceleration would need to be set to 4.615 revs/sec^2.



Supported Motors

The PowerFlex 755 can be used with a variety of both induction and permanent magnet (PM) motors.

AC Induction Motors

An AC induction motor uses slip between the rotor and the stator to create torque. Some motor manufacturers specify the synchronous speed instead of slip speed on the motor nameplate. For example, a 4 pole, 60 hertz motor has a synchronous speed of 1800 rpm. The drive algorithm cannot use the synchronous speed, it needs the slip rpm. The slip rpm is the rotor speed when the stator is at rated frequency and the motor is at full load. The rotor will slip behind the stator to create the torque. For a 4 pole, 60 hertz motor the slip rpm range is 1700...1790 rpm. If the nameplate is showing synchronous speed (in our example 1800 rpm), please contact the motor manufactures to receive the slip rpm.

Some AC motors have two voltage ratings, a high voltage and a low voltage. Follow the motor manufacture's wiring diagram to correctly wire the motor for the proper voltage.

All motor manufactures provide an electrical specification including an electrical model equivalent. If you believe that the PowerFlex drive family is not producing the correct motor torque, please contact the motor manufacturer to receive the electrical specification prior to contacting Rockwell Automation Technical Support.

This list contains the name of manufacturers that produce motors that are recommended for use with PowerFlex 755 drives.

Manufacturer	Notes
Baldor Electric Company	Work well with PowerFlex 755 drives.
Baumuller	Work well with PowerFlex 755 drives.
Elin	Work well with PowerFlex 755 drives.
Electrical Apparatus Company (EAC)	Induction motors work well with PowerFlex 755 drives.
Lenze	Some Lenze motors have been stamped with synchronous speed versus slip speed. Please contact Lenze to get the slip speed.
Marathon Electric	Work well with PowerFlex 755 drives. Marathon stamps all pertinent information on their nameplate including electrical model equivalent.
Reliance	RPM AC motors are used in industry and work well with PowerFlex 755 drives.
Reuland Electric Company, Inc.	Work well with PowerFlex 755 drives. Reuland stamps the motor with synchronous speed and then supplies the slip frequency. You must calculate the slip frequency in rpm and then subtract the slip rpm from the synchronous speed to get the slip speed. Before contacting Rockwell Automation Technical Support, please obtain the electrical specification sent with the motor.
Rockwell Automation	8720 and HPK motors work well with PowerFlex 755 drives. See the appropriate motor manual for the proper nameplate voltage.
SEW-EURODRIVE	SEW-EURODRIVE gear motors are widely used in industry and work well with PowerFlex 755 drives. Some of the older motors were stamped with synchronous speed versus slip speed. Please contact SEWS if the motor is stamped with synchronous speed. If you are using an SEW motor with an integral brake, please verify that the brake is properly suppressed for noise.

Manufacturer	Notes
WEG Electric Corp.	WEG motors may have a start winding and a run winding. Always wire the drive to the run winding.
Wittenstein	Work well with PowerFlex 755 drives.
Wound rotor manufacturers	Wound Rotors work with PowerFlex 755 drives. You must short the external resistors when using these motors.

Permanent Magnet Motors

Most permanent magnet motors are compatible with the PowerFlex 755 drive. You must obtain the motor manufacturer's specification for the motor prior to contacting Rockwell Automation Technical Support.

PowerFlex 755 drives cannot accept a resolver. Therefore, the motors must have either a pulse encoder or absolute feedback device (for example, SSI, Heidenhain, Stegmann/Sick hyperface).

This list contains the name of manufacturers that produce motors that are recommended for use with PowerFlex 755 drives.

Manufacturer	Notes
Baldor Electric Company	Work well with PowerFlex 755 drives. Verify that you are using either the Surface Mount (SM) or Interior Mounted (IPM) motors and select the appropriate control algorithm.
KollMorgan	Work well with PowerFlex 755 drives.
Oswald Electric Motors	
PowerTec	Work well with PowerFlex 755 drives, but cannot use resolver feedback.
Rockwell Automation	MPL, MPM, and RDB motors work well with PowerFlex drives. Use Heidenhain feedback for RDB motors.

Compatible HPK Motors

The following table contains a list of specifications for Bulletin HPK-Series™ high-power asynchronous motors that are compatible with PowerFlex 750-Series drives. This information is provided to help configure PowerFlex 750-Series drives with the appropriate motor data.

Cat. No.	Base Speed	KW	Volts	Amps	Hz	Torque (N•m)	Peak Torque (N•m)	Peak Amps	IM Amps	R1	R2	X1	X2	Xm
HPK-B1307C-MA42AA	1465	17.1	400	34.2	50	112	260	80	15.8	0.181	0.119	0.65	0.704	14.7
HPK-B1307C-SA42AA	1465	17.1	400	34.2	50	112	260	80	15.8	0.181	0.119	0.65	0.704	14.7
HPK-B1307E-MA42AA	2970	29.8	405	57.5	100	96	165	104	26.1	0.0485	0.0338	0.371	0.423	8.79
HPK-B1307E-MB44AA	2970	29.8	405	57.5	100	96	165	104	26.1	0.0485	0.0338	0.371	0.423	8.79
HPK-B1307E-MC44AA	2970	29.8	405	57.5	100	96	165	104	26.1	0.0485	0.0338	0.371	0.423	8.79
HPK-B1307E-SA42AA	2970	29.8	405	57.5	100	96	165	104	26.1	0.0485	0.0338	0.371	0.423	8.79
HPK-B1307E-SB44AA	2970	29.8	405	57.5	100	96	165	104	26.1	0.0485	0.0338	0.371	0.423	8.79
HPK-B1308E-MA42AA	2970	33.5	405	64.8	100	115	230	135	28.8	0.037	0.0275	0.296	0.364	7.71
HPK-B1308E-MB44AA	2970	33.5	405	64.8	100	115	230	135	28.8	0.037	0.0275	0.296	0.364	7.71
HPK-B1308E-SA42AA	2970	33.5	405	64.8	100	115	230	135	28.8	0.037	0.0275	0.296	0.364	7.71
HPK-B1308E-SB44AA	2970	33.5	405	64.8	100	115	230	135	28.8	0.037	0.0275	0.296	0.364	7.71
HPK-B1609E-MA42AA	2965	48.4	405	88.2	100	156	270	154	31.4	0.0326	0.0227	0.288	0.319	7.23
HPK-B1609E-SA42AA	2965	48.4	405	88.2	100	156	270	154	31.4	0.0326	0.0227	0.288	0.319	7.23
HPK-B1609E-SB44AA	2965	48.4	405	88.2	100	156	270	154	31.4	0.0326	0.0227	0.288	0.319	7.23
HPK-B1609E-X169	2965	48.4	460	88.2	154	156	270	154	154	154	154	154	154	154
HPK-B1611E-MA42AA	2975	57	408	105.7	100	183	400	240	47.6	0.0205	0.0152	0.167	0.219	4.82
HPK-B1611E-MB44AA	2975	57	408	105.7	100	183	400	240	47.6	0.0205	0.0152	0.167	0.219	4.82
HPK-B1611E-SA42AA	2975	57	408	105.7	100	183	400	240	47.6	0.0205	.0.0152	0.167	0.219	4.82
HPK-B1613E-MA42AA	2970	73.7	407	135.3	100	237	520	312	54.5	0.0164	0.0127	0.136	0.179	4.21
HPK-B1613E-MB44AA	2970	73.7	407	135.3	100	237	520	312	54.5	0.0164	0.0127	0.136	0.179	4.21
HPK-B1613E-SA42AA	2970	73.7	407	135.3	100	237	520	312	54.5	0.0164	0.0127	0.136	0.179	4.21
HPK-B1613E-SB44AA	2970	73.7	407	135.3	100	237	520	312	54.5	0.0164	0.0127	0.136	0.179	4.21

Cat. No.	Base Speed	KW	Volts	Amps	Hz	Torque (N•m)	Peak Torque (N•m)	Peak Amps	IM Amps	R1	R2	X1	X2	Xm
HPK-B2010E-MA42BA	2985	112	400	216	100	358			35	0.00519	0.00419	0.0626	0.097	2.03
HPK-B2010E-SA42BA	2985	112	400	216	100	358			35	0.00519	0.00419	0.0626	0.097	2.03
HPK-E1308E-MA42AA	2975	33.5	330	80	100	108	216	160	39	0.0233	0.0176	0.189	0.242	4.92
HPK-E1308E-MB44AA	2975	33.5	330	80	100	108	216	160	39	0.0233	0.0176	0.189	0.242	4.92
HPK-E1308E-MC44AA	2975	33.5	330	80	100	108	216	160	39	0.0233	0.0176	0.189	0.242	4.92
HPK-E1308E-SA42AA	2975	33.5	330	80	100	108	216	160	39	0.0233	0.0176	0.189	0.242	4.92
HPK-E1308E-SB44AA	2975	33.5	330	80	100	108	216	160	39	0.0233	0.0176	0.189	0.242	4.92
HPK-E1308E-SC44AA	2975	33.5	330	80	100	108	216	160	39	0.0233	0.0176	0.189	0.242	4.92
HPK-E1609E-MA42AA	2965	48.4	405	88.2	100	108	216	160	39	0.0233	0.0176	0.189	0.242	4.92
HPK-E1613E-SA42AA	2975	73.7	400	172	385	237	520	385	385	385	385	385	385	385

Third-Party Permanent Magnet Motors

The PowerFlex 755 drive can support third-party permanent magnet motors without the need of custom profiles. However, the motor nameplate information may need to be modified. Rockwell Automation Technical Support requires the following information to assist you in modifying the motor data for use with the drive. Please complete the following tables and email the information to Rockwell Automation Technical Support at: support@drives.ra.rockwell.com.

Table 23 - Permanent Magnet Motor Specifications and Evaluation

Motor Manufacturer	
Model Number	

Feedback Device		
Type of Feedback		If resolver, please complete resolver information
Feedback Manufacturer		
Feedback Model Number		

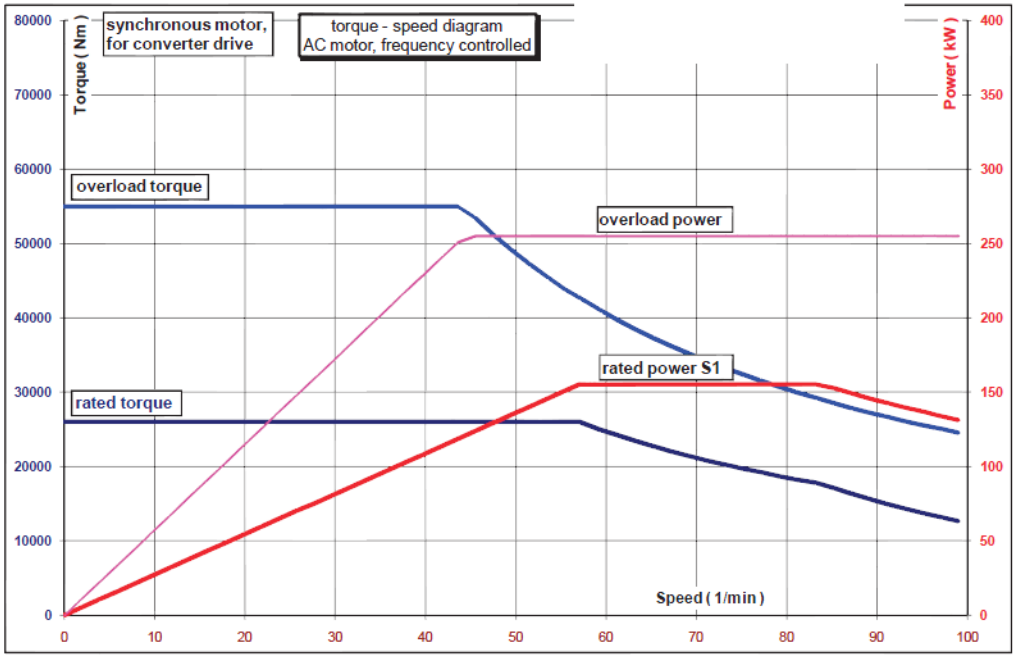
Technical Specifications					
Item	**Symbol**	**Value**	**Units**	**Notes**	
Maximum Mechanical Speed	n		rpm		
Continuous Stall Torque	Ms		Nm	(This should be RMS not 0-peak)	
Continuous Stall Current	A		A	(This should be RMS not 0-peak)	
Peak Torque	Mj		Nm	(This should be RMS not 0-peak)	
Torque Weight Ratio	Tw		Nm/Kg		
EMF Constant	Ke		Vs/rad		Vs/1000rpm
Torque constant	Kt		Nm/A		
Reluctance Torque (with respect to Stall Torque)	Tr		Nm		
Winding Resistance	R		Ohms		line to line
Winding Inductance	L		mH		line to line
Rotor Inertia	J		kg-m2		
Mechanical Time Constant	Tm		ms		
Electrical Time Constant	Te		ms		
Mass	M		Kg		
Radial Load	Fr		N		
Axial Load	Fa		N		
Insulation					
Protection					

Motor Nameplate Voltage	V		Volts	
Motor Nameplate Power	Pwr		KW	
Poles	p			

Table 24 - Drive Motor Parameter Values

Parameter	Value	Units
P1: Motor Nameplate volts Vrms		Volts
P2: Motor Nameplate Amps		Amps
P3: Motor Nameplate Frequency		HZ
P4: Motor Nameplate RPM		RPM
P5: Motor Name Plate Power		KW
P7: Pole Pairs		
Zpu		
IXO Voltage drop		Volts
IR Voltage Droop		Volts
P523 Back Emf		Volts

Provide a Speed Torque profile like in this example.



System Tuning

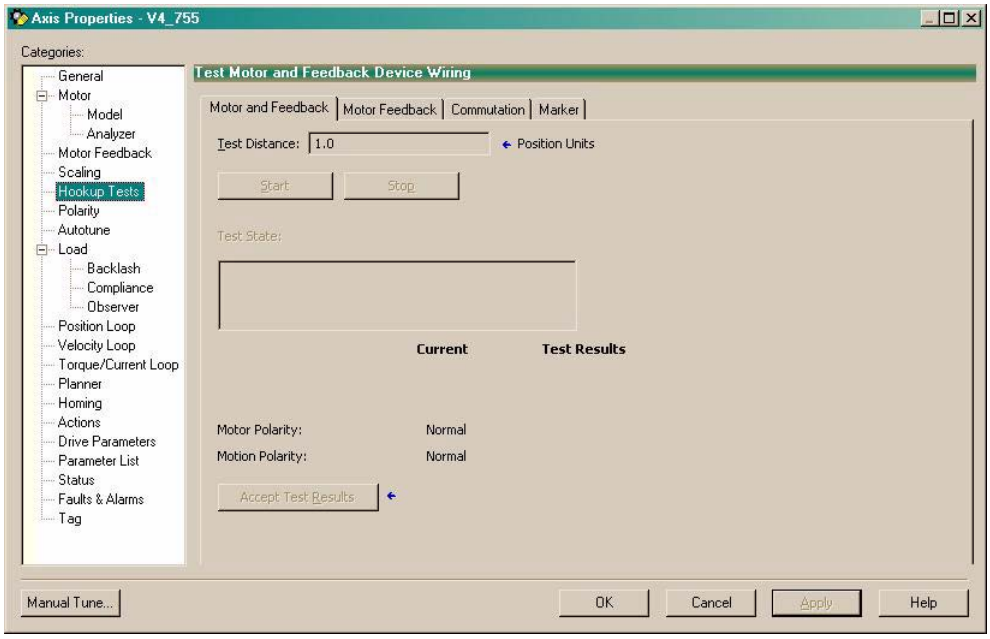
When using the Integrated Motion on the Ethernet/IP Network connection with the PowerFlex 755 drive, the tuning of the motion system is accomplished via RSLogix 5000. This topic describes the axis hookup tests, motor tests, and autotuning of the motion system required to measure the system inertia. Manual tuning of the axis is also described in this section:

- For additional information on axis attributes and the RSLogix 5000 software Control Modes and Methods, see the Integrated Motion on the Ethernet/IP Network Reference Manual, publication MOTION-RM003.
- For start-up assistance of a Integrated Motion on the EtherNet/IP Network Axis, see the Integrated Motion on the Ethernet/IP Network Configuration and Startup User Manual, publication MOTION-UM003.

This topic assumes that you have completed all the steps necessary to configure the drive module.

Axis Hookup Tests

The axis Hookup tests are the first tests to run when autotuning an axis. If you are using a permanent magnet motor in your application, the Commutation test must be run first, as part of the Hookup tests.



Motor and Feedback: This test is used to run the motor and verify the correct direction of rotation, and will also test the motor feedback for the proper direction:

- The Test Distance value can be defined to be sure that the system does not rotate too far.
- Click Start to initiate the test. The test will complete and prompt you to verify that the motor rotation direction was correct.

- When the test has been completed, click Accept Test Results to save the results.

Motor Feedback: This test is used to test the polarity of the motor feedback:

- Click Start and manually rotate the motor in the positive direction for the distance indicated in the Test Distance box.
- When the test has been completed, click Accept Test Results to save the results.

Commutation: When using a permanent magnet motor, this test must be run first. The Commutation test is used to measure the commutation offset angle for the permanent magnet motor.

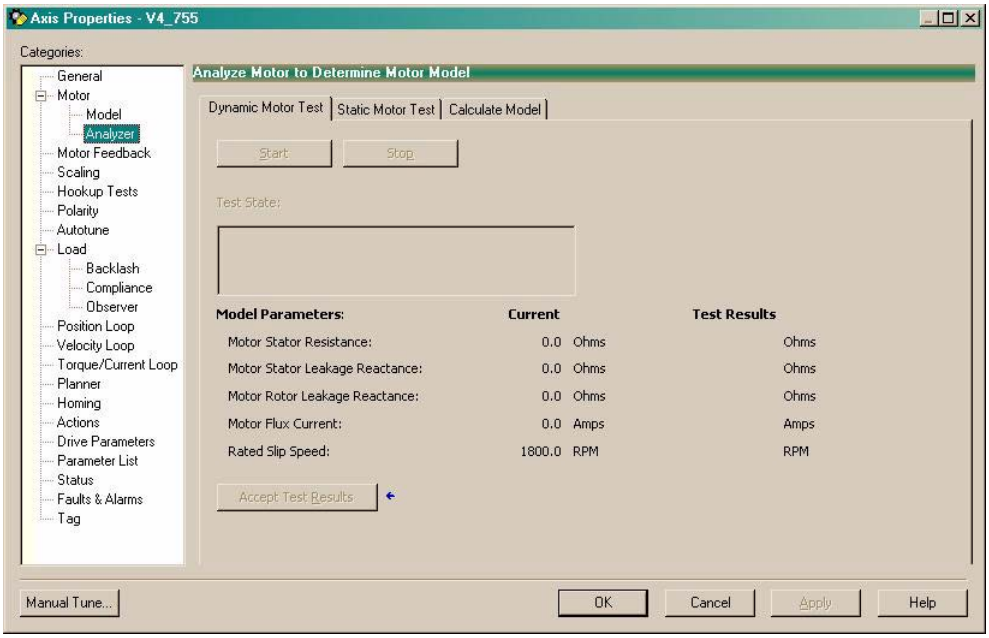
- When the test has been completed, click Accept Test Results to save the results.
- Use the resulting Controller Offset value.

Marker: This test is used to check for the marker pulse on an incremental encoder:

- Click Start and manually move the motor until a marker pulse is detected.
- When the marker pulse is detected the test will stop. Click Accept Test Results to save the results.

Motor Analyzer

The Motor Analyzer category offers three choices for calculating or measuring motor electrical data.



Dynamic Motor Test: This test is the most accurate test method to determine the motor model parameters. When this test is run the Resistance and Reactance

are measured then the motor is rotated to measure the flux current of the Induction motor. The Rated Slip frequency is also calculated:

- This test is best run with the motor disconnected from the load as the motor will spin for some time and there are no travel limits.
- When the test has been completed, click Accept Test Results to save the results.

Static Motor Test: This test is used if the motor cannot rotate freely or is already coupled to the load. When this test is run the Resistance and Reactance are measured then the flux current of the motor is calculated. The Rated Slip frequency is also calculated:

- The motor will not turn during this test.
- When the test has been completed, click Accept Test Results to save the results.

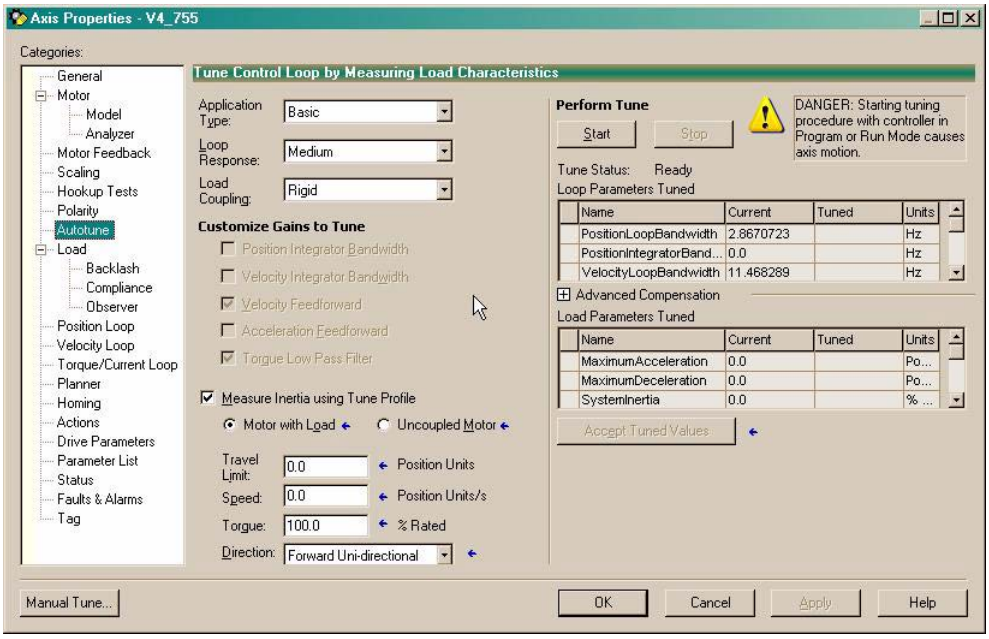
Calculate Model: This method calculates the Resistance, Reactance, and Flux Current of the motor from basic model parameters and the motor parameters data. No measurements are taken when using this calculation:

- Click Start to start the calculation.
- When the test has been completed, click Accept Test Results to save the results.

Autotune (inertia test)

The Autotune category measures the system inertia and calculates system bandwidth tuning numbers. This table summarizes the application type tuning defaults. An "X" indicates that the system value is selected by default and that the Velocity and Acceleration Feedforward values will be set to 100%.

Application Type	System Value						
	Position Loop Bandwidth	Position Integrator Bandwidth	Velocity Loop Bandwidth	Velocity Integrator Bandwidth	Integrator Hold	Velocity Feedforward	Acceleration Feedforward
Custom: (Advanced tuning)	X		X				
Basic: (Default tuning parameters)	X		X				
Tracking: (Winding/unwinding, flying shear, and web control applications)	X		X	X		X	X
Point-to-Point: (Pick-and-place, packaging, cut-to-length)	X	X	X		X		
Constant Speed: (Conveyors, line shaft, crank)	X		X	X		X	



Application Type: Specify the type of motion control application that will be tuned:

- **Custom:** This option lets you select the type of gains to use in the system. You can individually select gains to be used with the check boxes that display below Customize Gains to Tune heading.
- **Basic:** This selection is used for applications where following error and final position is not critical. Basic tuning gains include Position Loop proportional and Velocity Loop proportional.
- **Tracking:** This selection provides the most aggressive tuning. It is used to keep following error to a minimum and applies to both Velocity Feedforward and Acceleration Feedforward. This tuning selection uses Position Loop proportional, Velocity Loop proportional, and Velocity Loop integral.
- **Point to Point:** This selection is used for applications that use a move-to-position and do not need to include a following error. Tuning gains for this selection include Position Loop proportional, Position Loop integral, and Velocity Loop proportional.
- **Constant Speed**: This selection is used for constant speed applications. It is designed to keep velocity error to a minimum. It applies both Velocity Feedforward and uses Position Loop proportional, Velocity Loop proportional and Velocity Loop integral.

Loop Response: The Loop Response attribute is used to determine the responsiveness of the control loops. Specifically, the Loop Response attribute is used to determine the value for the Damping Factor (Z) used in calculating individual gain values:

- High = 0.8
- Medium = 1.0
- Low = 1.5

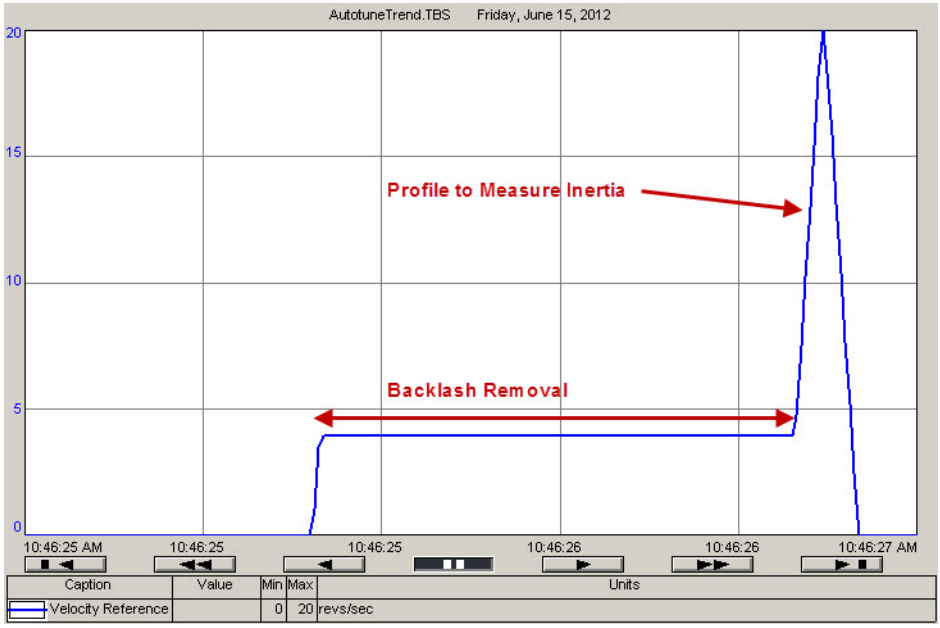
Load Coupling: The Load Coupling attribute is used to determine how the loop gains are de-rated based on the Load Ratio.

In high performance applications with relatively low Load Ratio values or rigid mechanics, typically Rigid is selected. The gains are not de-rated.

For applications with relatively high Load Ratios and compliant mechanics, Compliant is selected. The autotune algorithm divides the nominal loop bandwidth values by a factor of the Load Ratio + 1.

Measure Inertia using Tune Profile: Check this box to calculate the inertia tuned values as part of the autotune. The Inertia Test results are shown in the Inertia Tuned grid control (bottom right of the dialog box) when the test completes.

When Measure Inertia using Tune Profile is selected as a part of the Autotune test, the PowerFlex 755 drive will first jog or rotate the motor in a single direction to remove any backlash present in the system (as depicted in the chart below). After the backlash has been removed, the "bump" profile is then applied to measure the system inertia (system acceleration). Note that systems with a mechanical restriction or travel limit may not complete the Autotune test.



- **Motor with Load:** Choose this selection to calculate tuning values based on the load inertia. If selected, the load inertia is measured and then applied to the Total Inertia attribute or Total Mass attribute. The Load Ratio is also updated.

- **Uncoupled Motor:** Choose this selection to calculate tuning values based on the motor inertia. If selected, the motor inertia is measured during the test and is stored in the Rotary Motor Inertia attribute.

- **Travel Limit:** Enter a value that specifies the maximum distance to travel for the selected tune operation when the system has a limited travel distance. If the tuning test cannot complete within the distance specified the tune will fail and fault the axis.

- **Speed:** Enter a value that specifies the speed of the tune operation. A speed that translates to a minimum of 25% of the motor nameplate RPM is recommended.

- **Torque:** Enter a value in the range of 0...300 that specifies the torque value to be applied to the tune operation. The default value is 100.

- **Direction:** Choose the direction of the move for the tune operation. The available values include:

  - Forward Unidirectional (default)
  - Reverse Unidirectional
  - Forward Bi-Directional
  - Reverse Bi-Directional

Run the Autotune

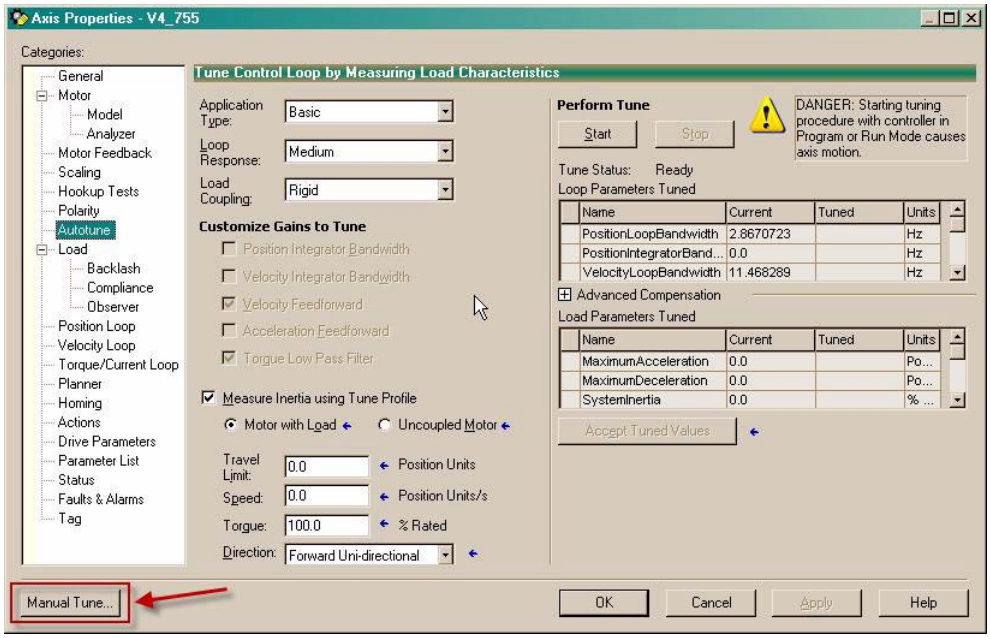
To start the autotune procedure, click Start:

- When the Measure Inertia using Tune Profile check box is selected, the request to start a tune is issued to the controller.
- Any pending edits in this dialog box need to be applied before you start the test. If you have pending edits, a message box appears informing you that pending edits will be applied prior to executing the test. Click Yes to apply the pending edits. If you choose No, the test will not be executed.
- Clicking Start issues a Motion Direct command to the controller, which causes any parameters used by the motion direct command to validate before starting the test.
- If the Motion Direct command does not execute due to an error condition, an error message appears and the Test State returns to the Ready state.
- Click Stop to terminate an autotune operation that was started from a source other than Start on this Autotune dialog box. When an Autotune is started from Start on this dialog box, Stop is unavailable.

When the autotune has completed, click Accept Tuned Values to accept the tuning results and before you can change any tuning categories.

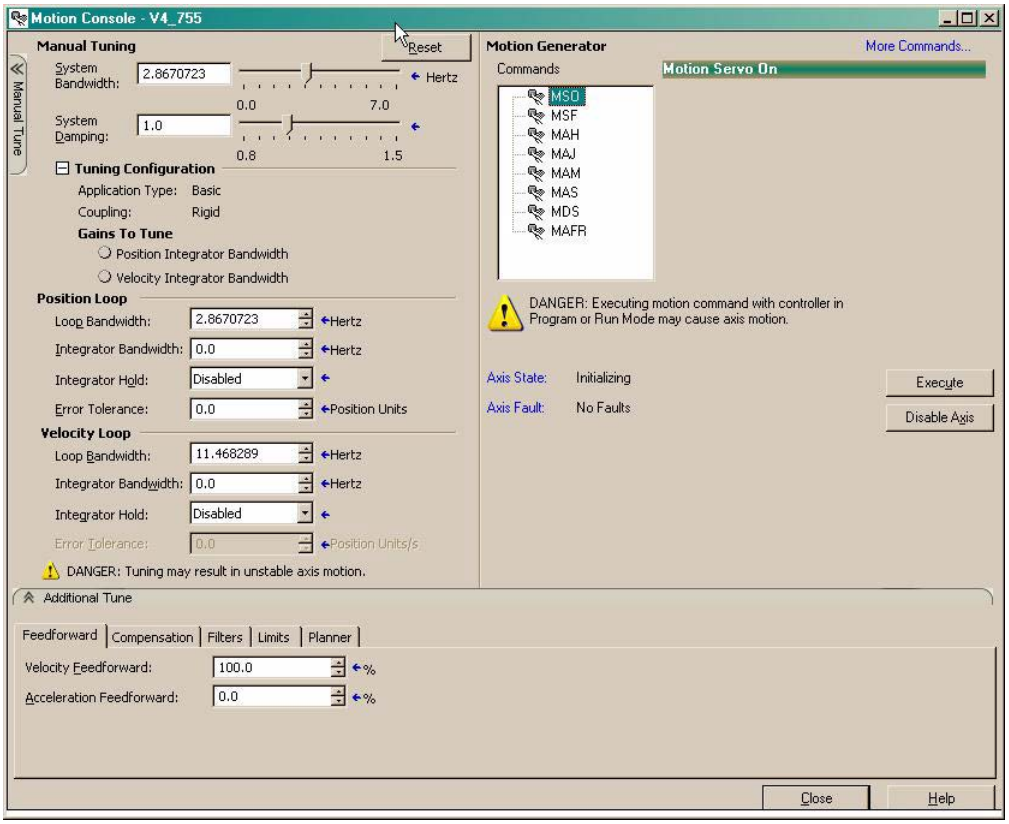
Manual Tune

The Integrated Motion on the Ethernet/IP network axis includes a method for manual tuning the axis gains. Clicking Manual Tune (as indicated in the example here) opens the Manual Tuning window.



Manual Tuning Window

Tuning gains are measured in Hertz in the Integrated Motion on the Ethernet/IP network connection compared to the radians/second in the stand alone drive. 6.283185 Rad/Sec = 1 Hz.



The Manual Tuning window contains three sections:

Manual Tuning Section: This section lets you customize the configuration of system tuning. The following two selections can be made:

- **System Bandwidth:** Changing this value will adjust the Position Loop and Velocity Loop response. The value selected in this field will change the Application Type selection in the Autotune window. Therefore, care must be taken to NOT change this value after the individual gains have been manually configured.

- **System Dampening:** Changing this value will adjust both the Dampening factor and System Bandwidth values. Lowering the System Dampening factor will dramatically increase the System Bandwidth. Care must be taken when changing this value to avoid machine damage. It is recommended that small incremental adjustments be made to the System Dampening while evaluating the overall system response. This value will change the Application Type selection in the Autotune window. Therefore, care must be taken to NOT change this value after the individual gains have been manually configured.

- **Position Loop:** You can manually adjust the Loop Bandwidth, Integrator Bandwidth, Integrator Hold and Error Tolerance values.

- **Velocity Loop:** You can manually adjust the Loop Bandwidth, Integrator Bandwidth, Integrator Hold, and Error tolerance (when used as a Velocity Loop) values.

Motion Generator Section: The Motion Generator is a subset of the Motion Direct commands that lets you control the axis motion for tuning.

Additional Tune Section: This section allows adjustment to multiple settings of the axis properties:

- **Feedforward Tab:** Lets you adjust the Velocity Feedforward percentage and Acceleration Feedforward percentage.

- **Compensation Tab:** Lets you adjust the System Inertia percentage and Torque Offset percentage.

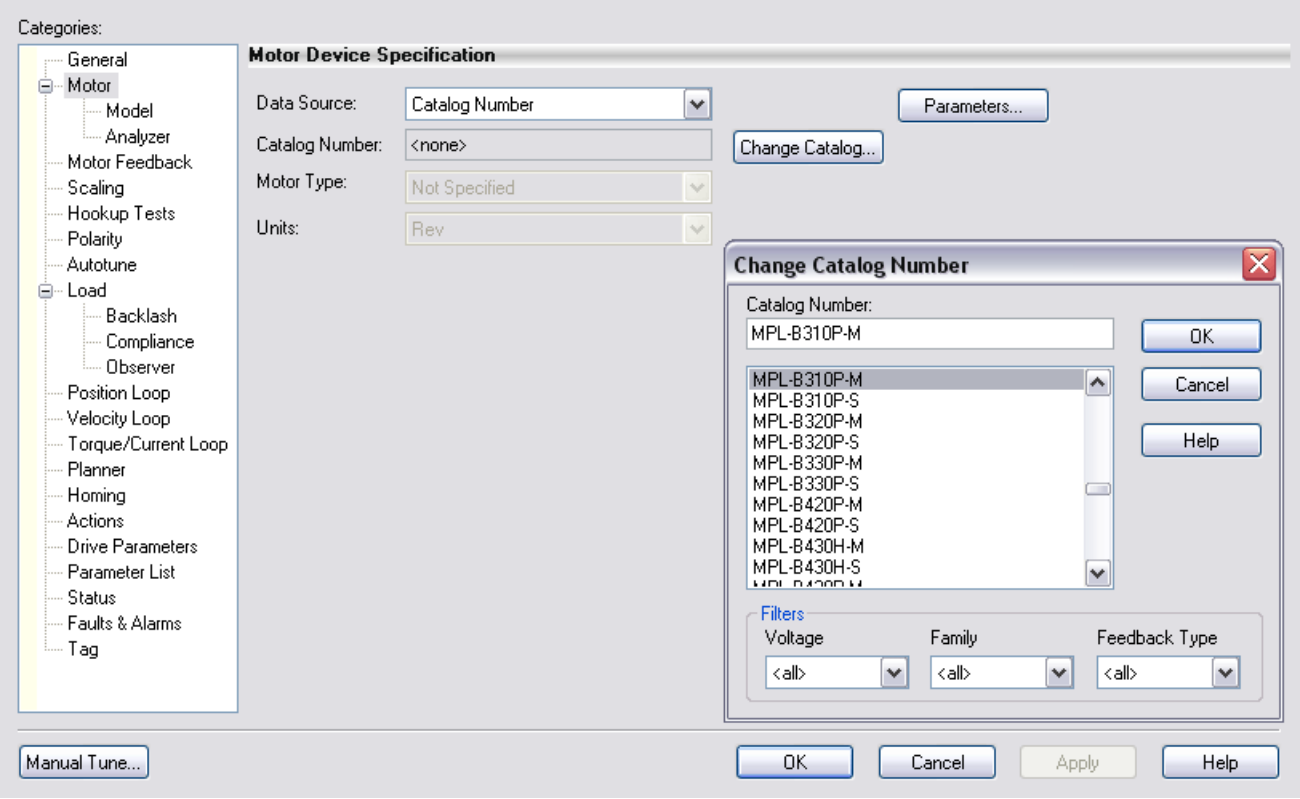
- **Filters Tab:** Lets you adjust the Torque Low Pass Filter Bandwidth and Torque Notch Filter Frequency.

- **Limits Tab:** Lets you adjust the Peak Torque Limit Positive / Negative percentages and Velocity Limit Positive / Negative Units per Second values.

- **Planner Tab:** Lets you adjust the Maximum Speed, Maximum Acceleration, Maximum Deceleration, Maximum Acceleration Jerk, and Maximum Deceleration Jerk values.

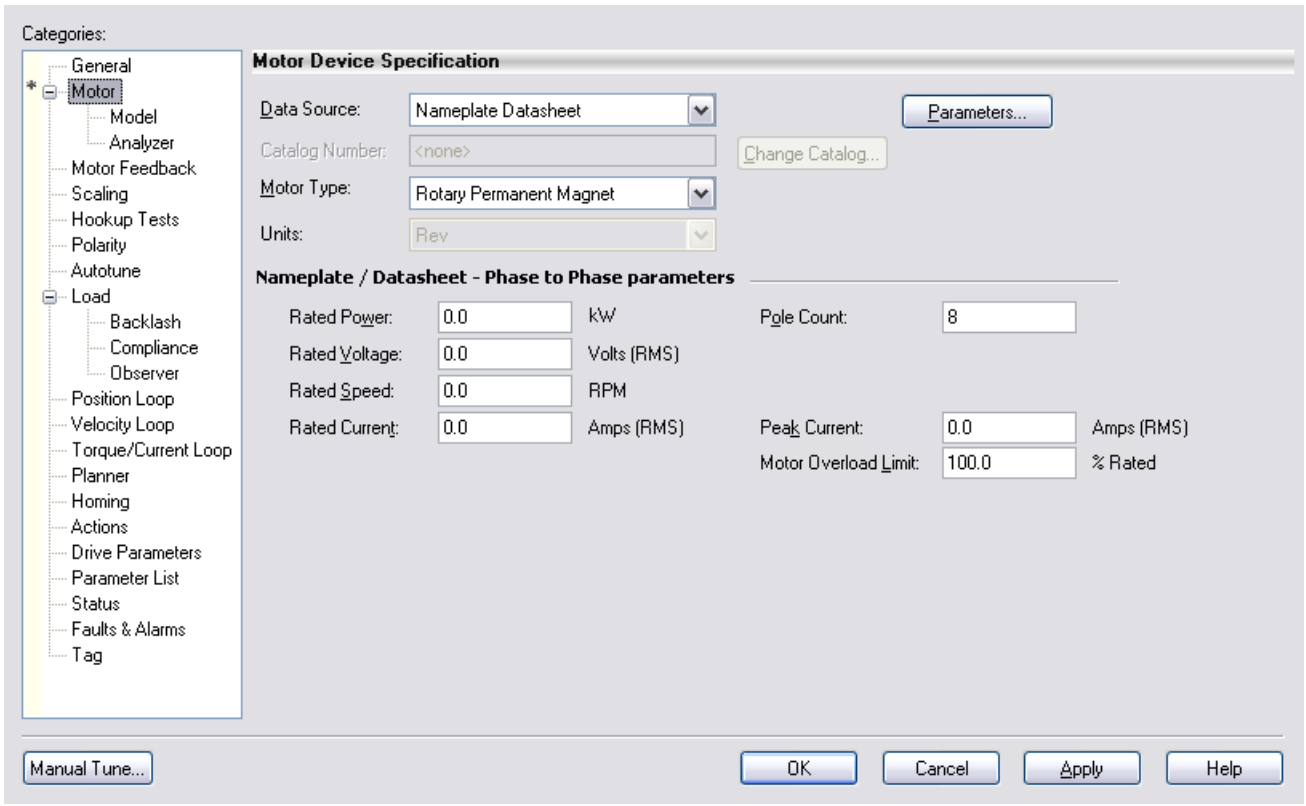
Using an Incremental Encoder with an MP*x* Motor

The PowerFlex 755 drive supports incremental encoder feedback when using a Rockwell Automation MP*x* motor. However, the Motor Device Specification category in the Axis Properties configuration for RSLogix 5000 does not currently support MP-Series™ motors with incremental feedback catalog numbers, as shown below. Only MP-Series motors with the suffix –M (Stegmann Multi-turn Absolute), or –S (Single Turn Absolute) motors are supported.



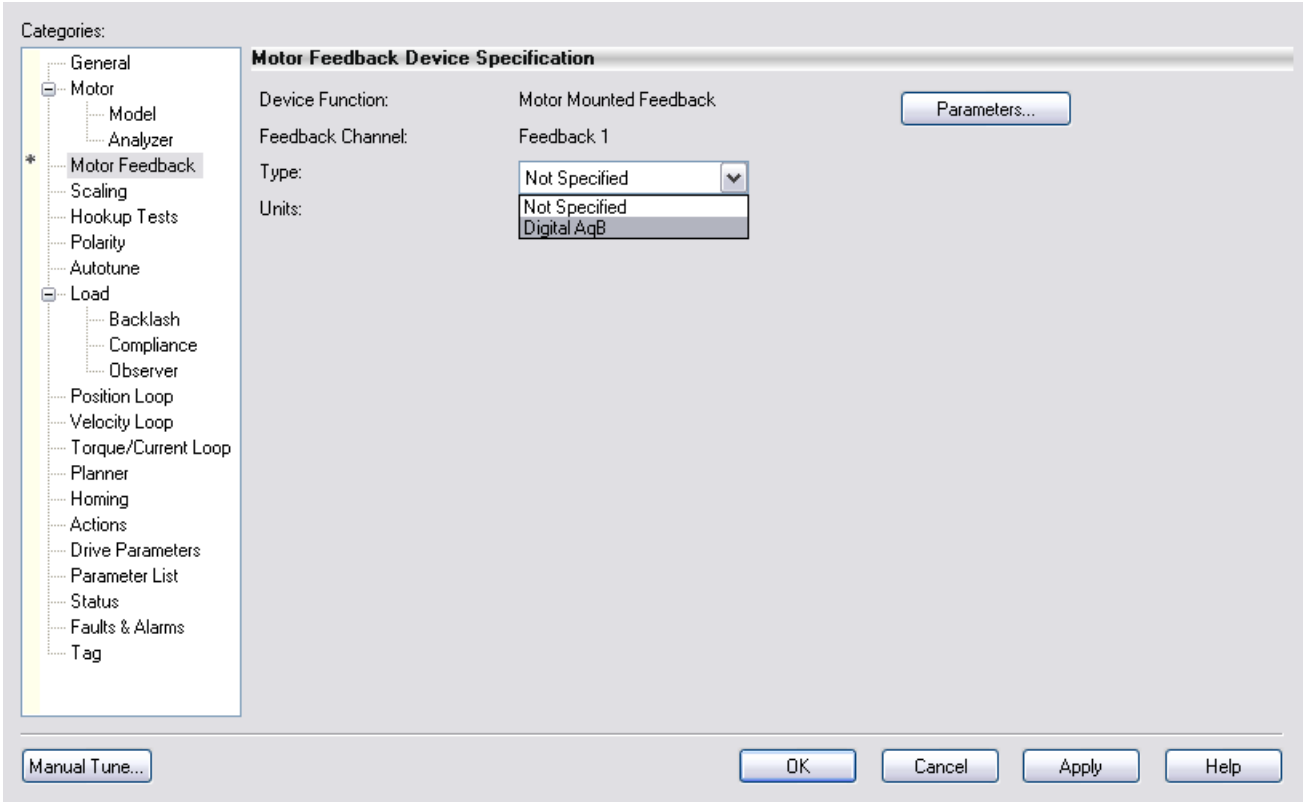
To configure a PowerFlex 755 drive with an MP*x* motor equipped with incremental encoder feedback, the MP*x* motor must be set up as a third-party motor. Follow these steps to configure an MP*x* motor with incremental encoder feedback for use with a PowerFlex 755 drive using the Integrated Motion on the EtherNet/IP Network.

1. In the Axis Properties dialog box for the drive, select these options (as shown below):
   - From the Data Source pull-down menu, choose Nameplate Datasheet.
   - From the Motor Type pull-down menu, choose Rotary Permanent Magnet.
2. You must manually enter the Nameplate / Datasheet – Phase to Phase parameters information. See Appendix D - Permanent Magnet Motors in the PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001, for a list of motor nameplate specification data.



TIP If you do not have a Programming Manual readily available, from the Data Source pull-down menu, choose Catalog Number. Then, from the Motor Type pull-down menu, choose the equivalent motor with the -M (Stegmann Multi-turn Absolute) device. RSLogix 5000 will populate the Nameplate / Datasheet – Phase to Phase parameters information with the data that is stored in the database. Record this information for reference. Then, change the Data Source selection to "Nameplate Datasheet." The configuration is transferred to the new selection. The motor data is the same regardless of the selected feedback device.

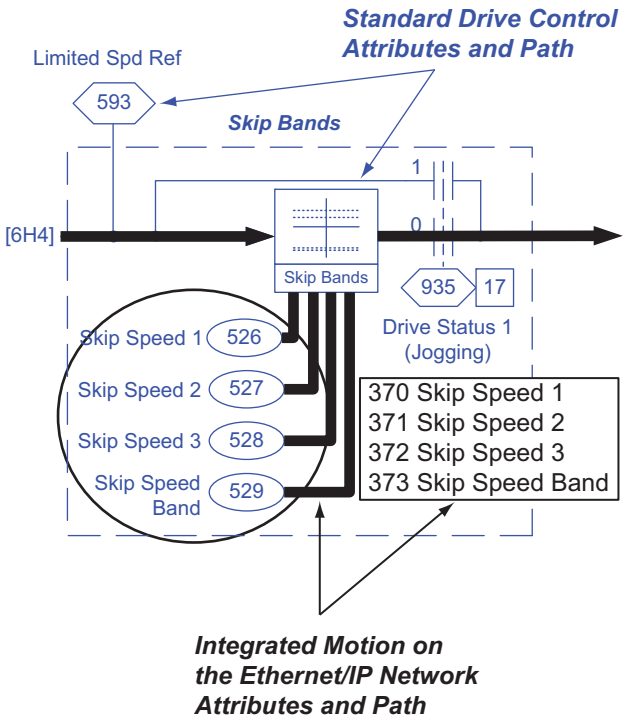
3. Select the Motor Feedback category.
4. From the Type pull-down menu, choose Digital AqB.



5. Click OK to save your configuration.

PowerFlex 755 Integrated Motion on the EtherNet/IP Network Block Diagrams

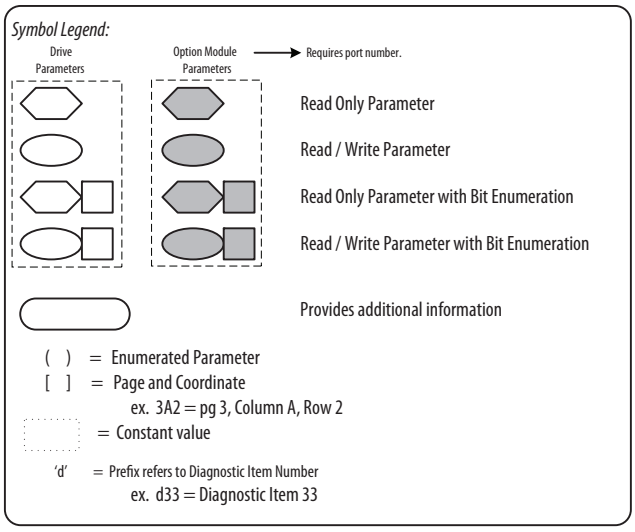
The block diagrams in this section highlight the Integrated Motion on the Ethernet/IP Network attributes and path used in PowerFlex 755 drives control. When viewed in electronic format (PDF), or when printed in color, the standard drive control attributes and path appear in blue and the Integrated Motion on the EtherNet/IP Network attributes appear in black and the path appears in black and uses heavier line weights.



Legend and Definitions

Use the following legend and definitions when viewing the diagrams.

Definitions of the Per Unit system:
1.0 PU Position = Distance traveled / 1sec at Base Spd
1.0 PU Speed = Base Speed of the Motor
1.0 PU Torque = Base Torque of the Motor


Symbol Legend:
Drive Parameters
Option Module Parameters
Requires port number.
Read Only Parameter
Read / Write Parameter
Read Only Parameter with Bit Enumeration
Read / Write Parameter with Bit Enumeration
Provides additional information
( ) = Enumerated Parameter
[ ] = Page and Coordinate
ex. 3A2 = pg 3, Column A, Row 2
= Constant value
'd' = Prefix refers to Diagnostic Item Number
ex. d33 = Diagnostic Item 33

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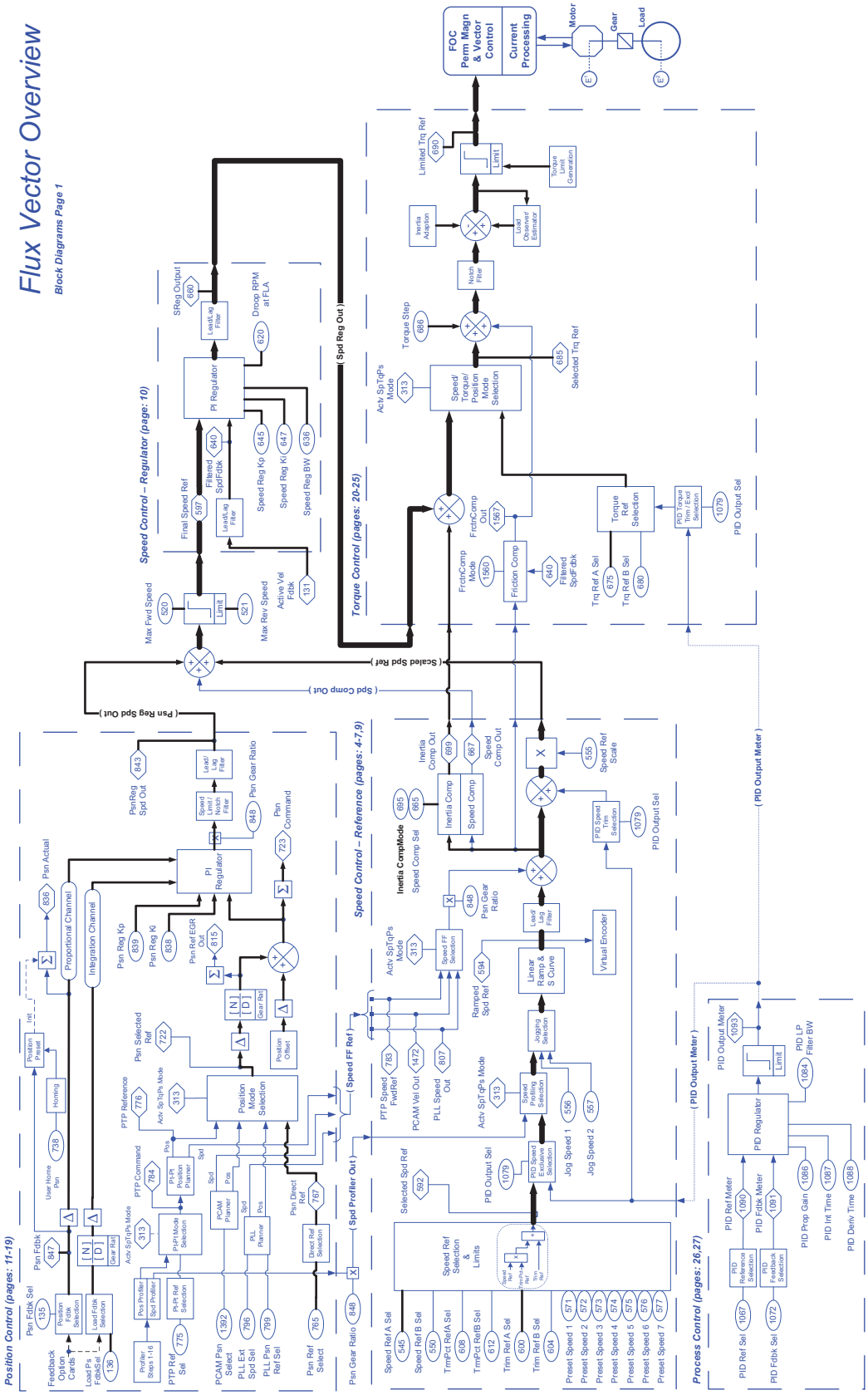
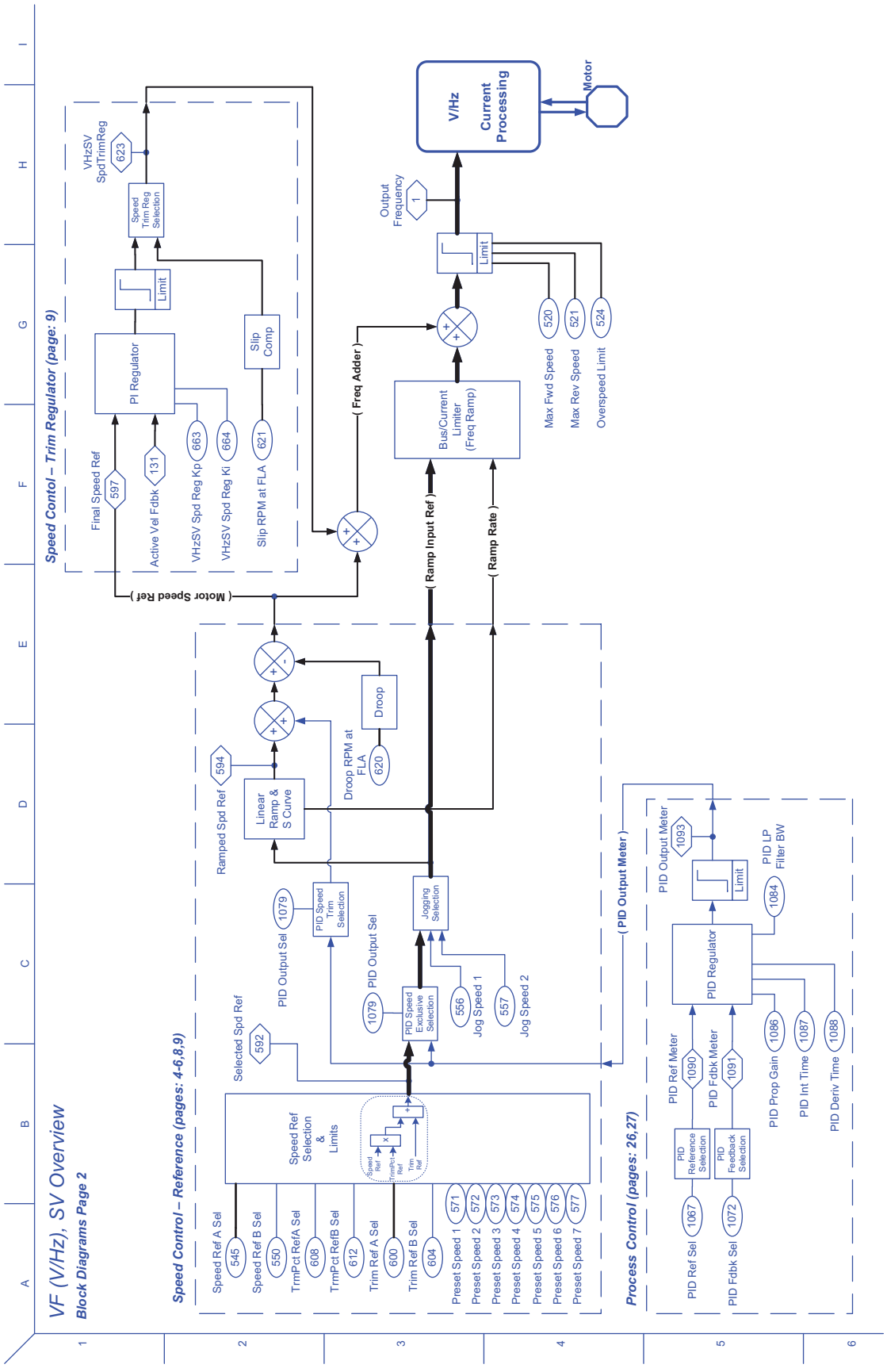
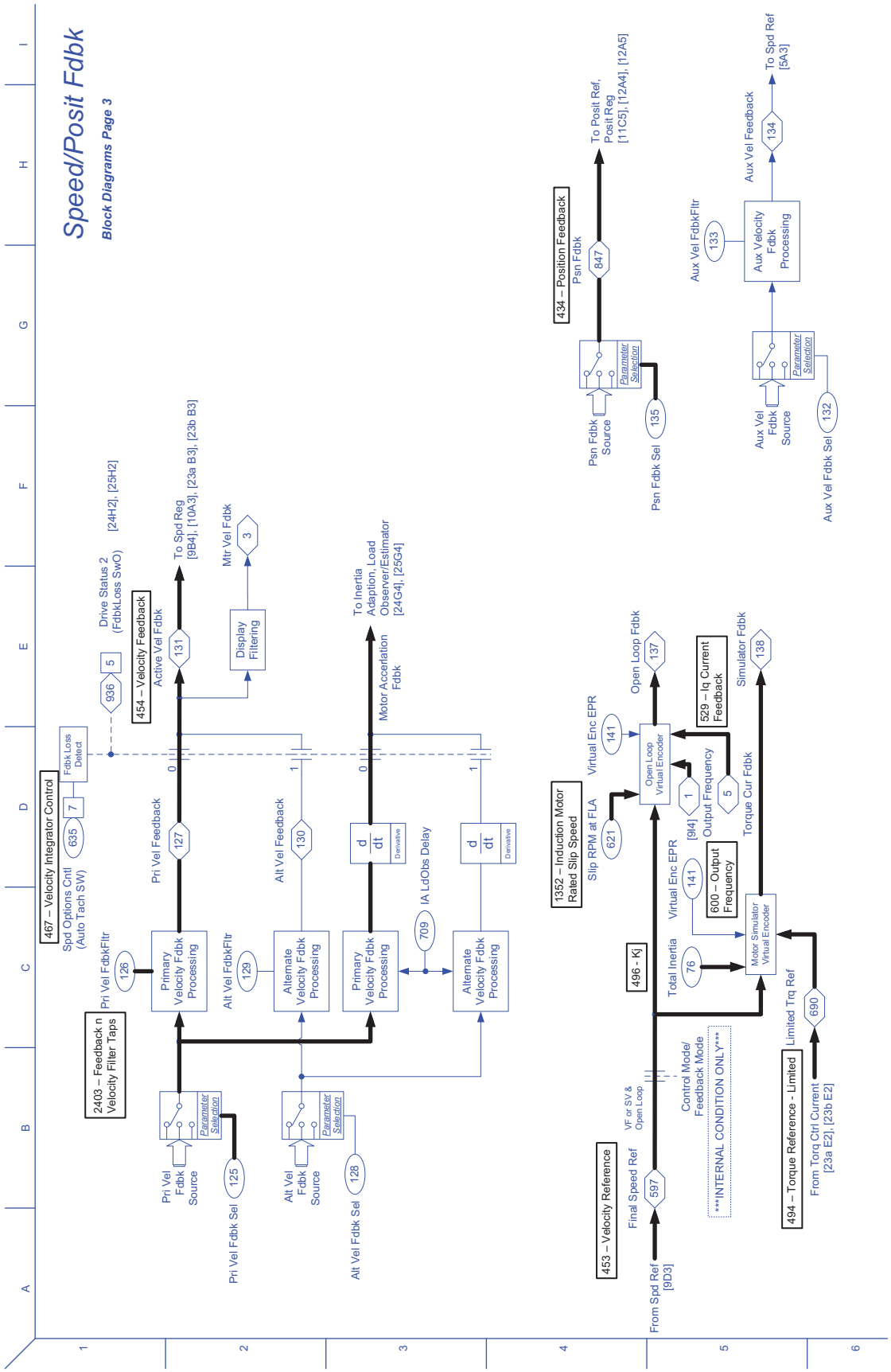
Flux Vector Overview



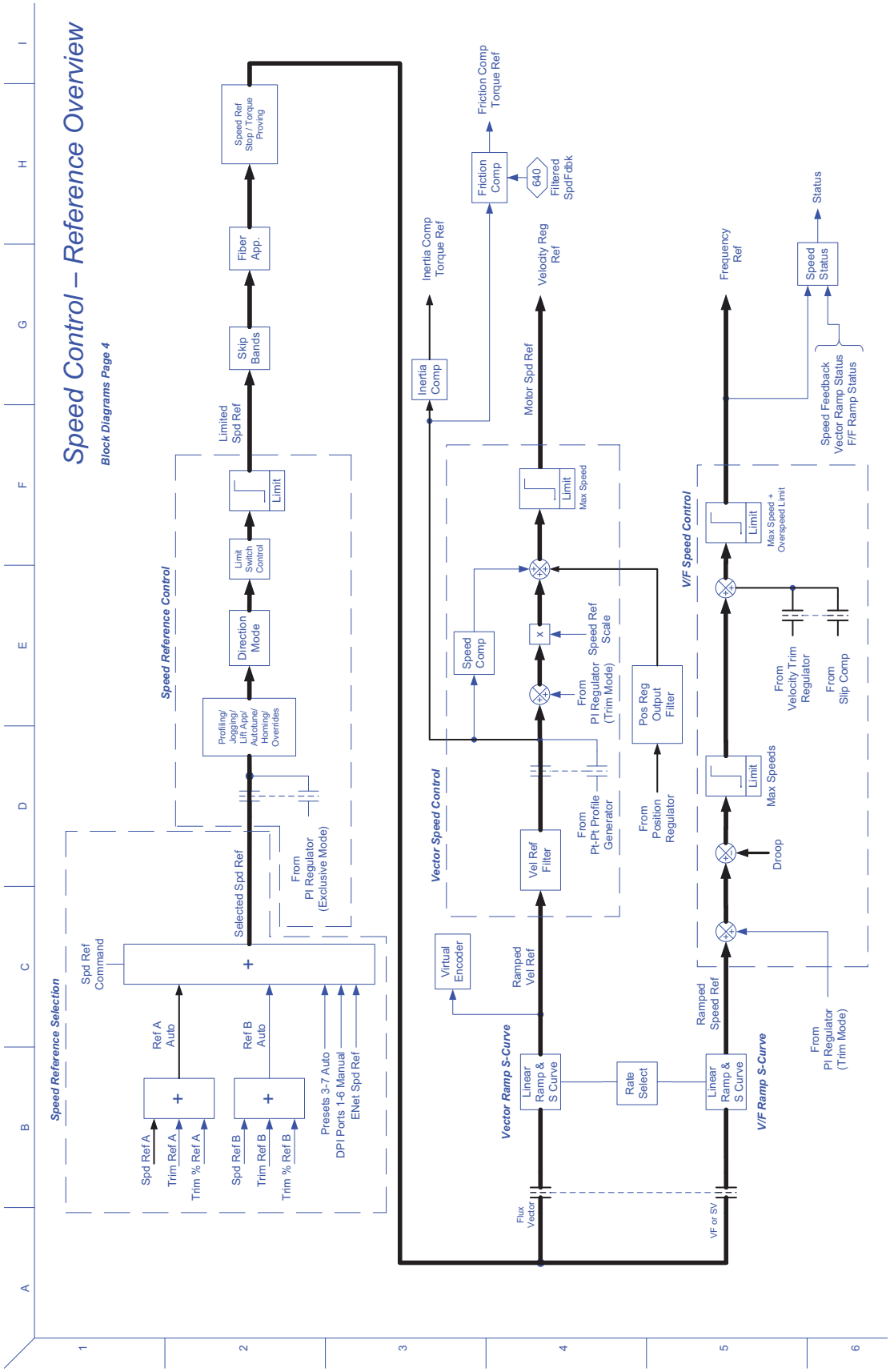
VF (V/Hz), SV Overview



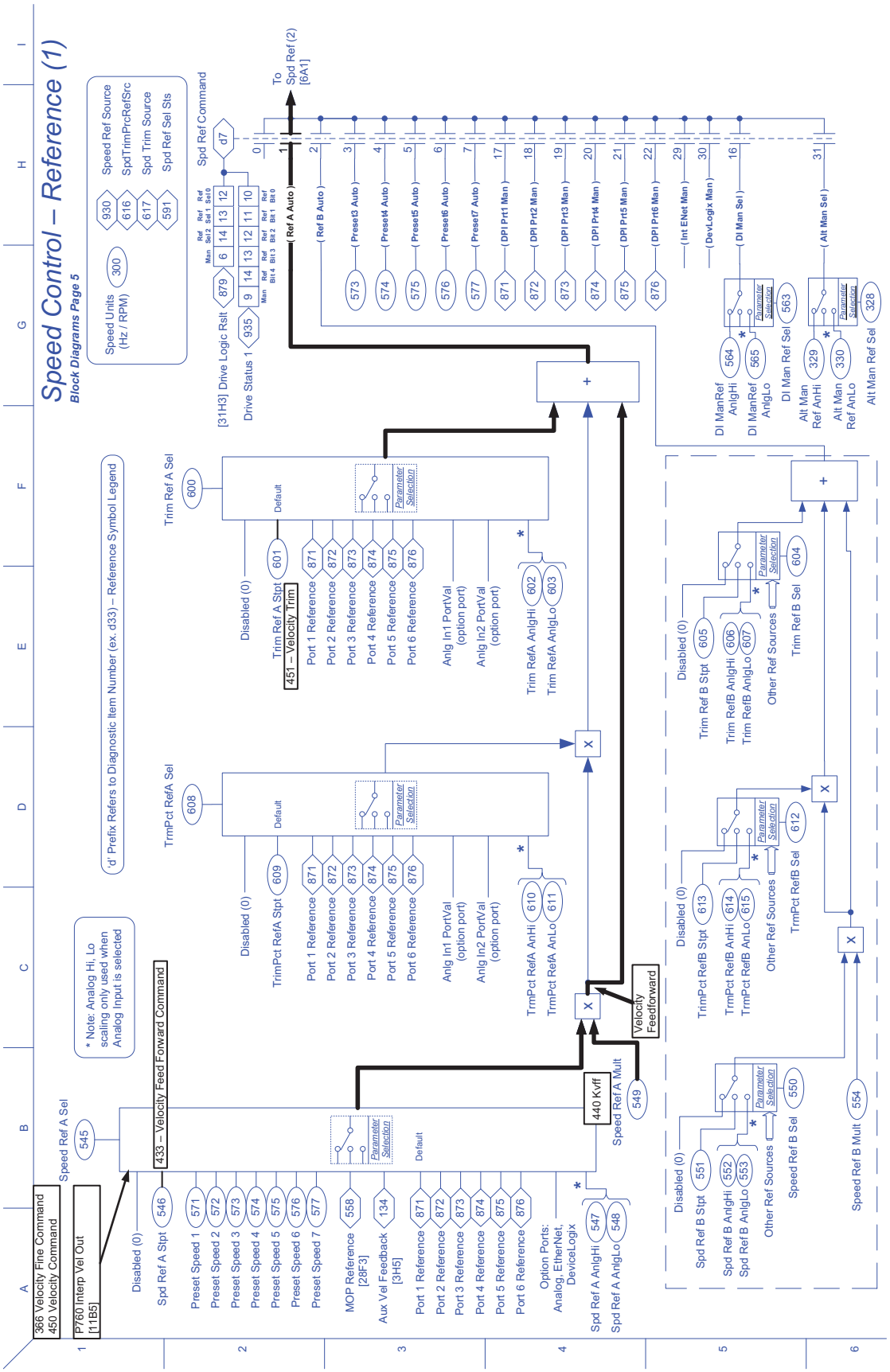
Speed / Position Feedback



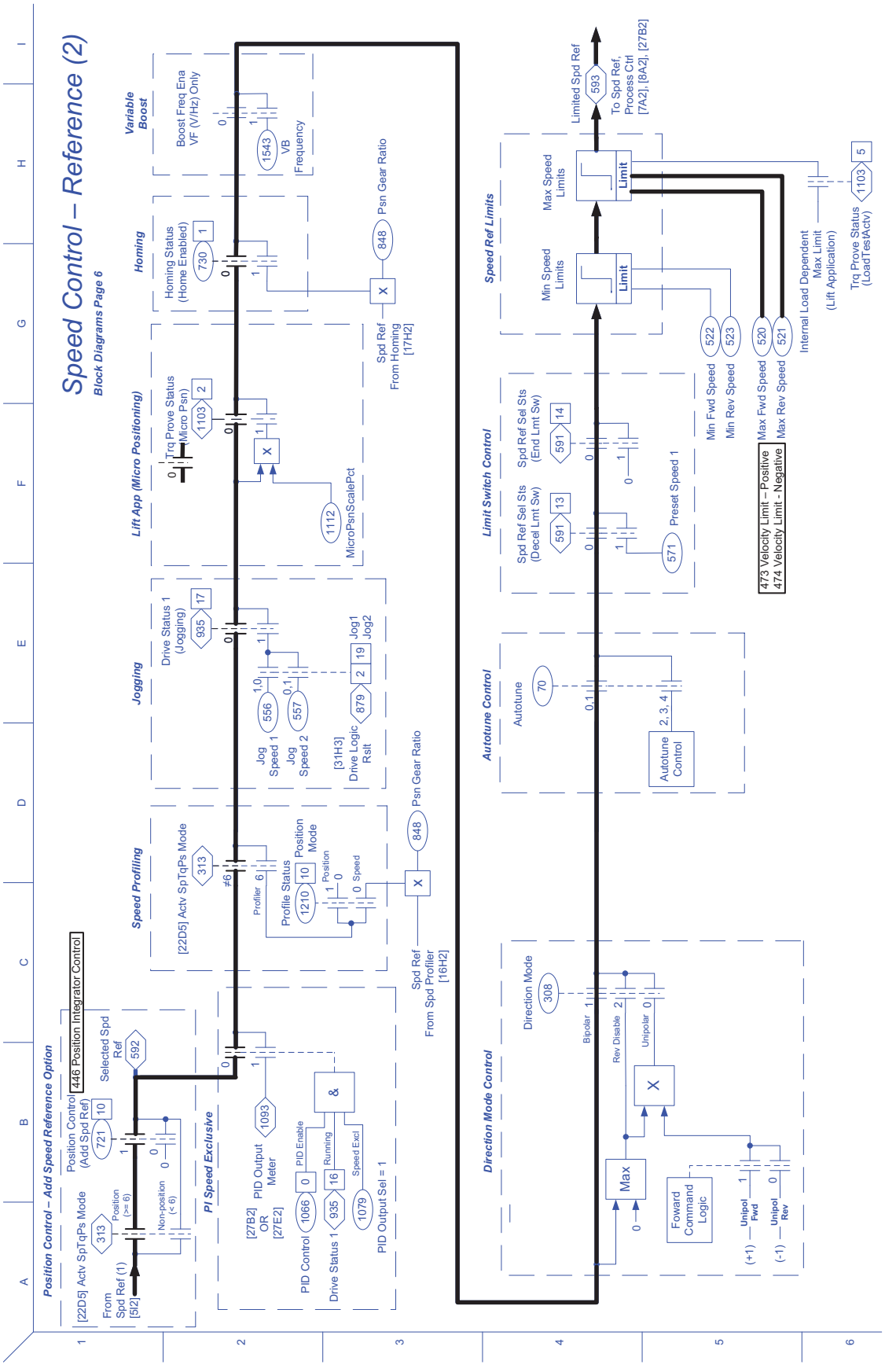
Speed Control - Reference Overview



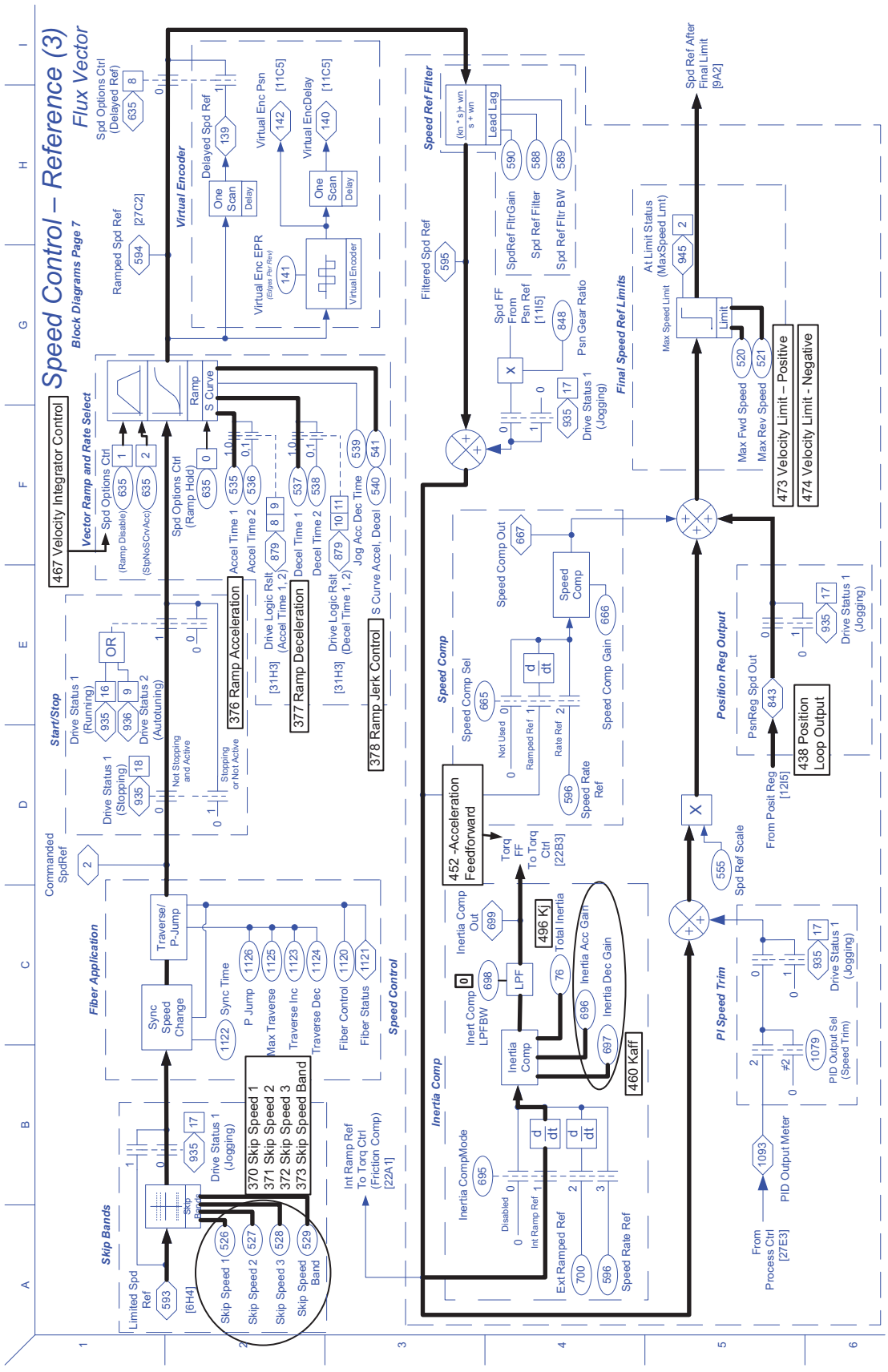
Speed Control Reference (Sheet 1)



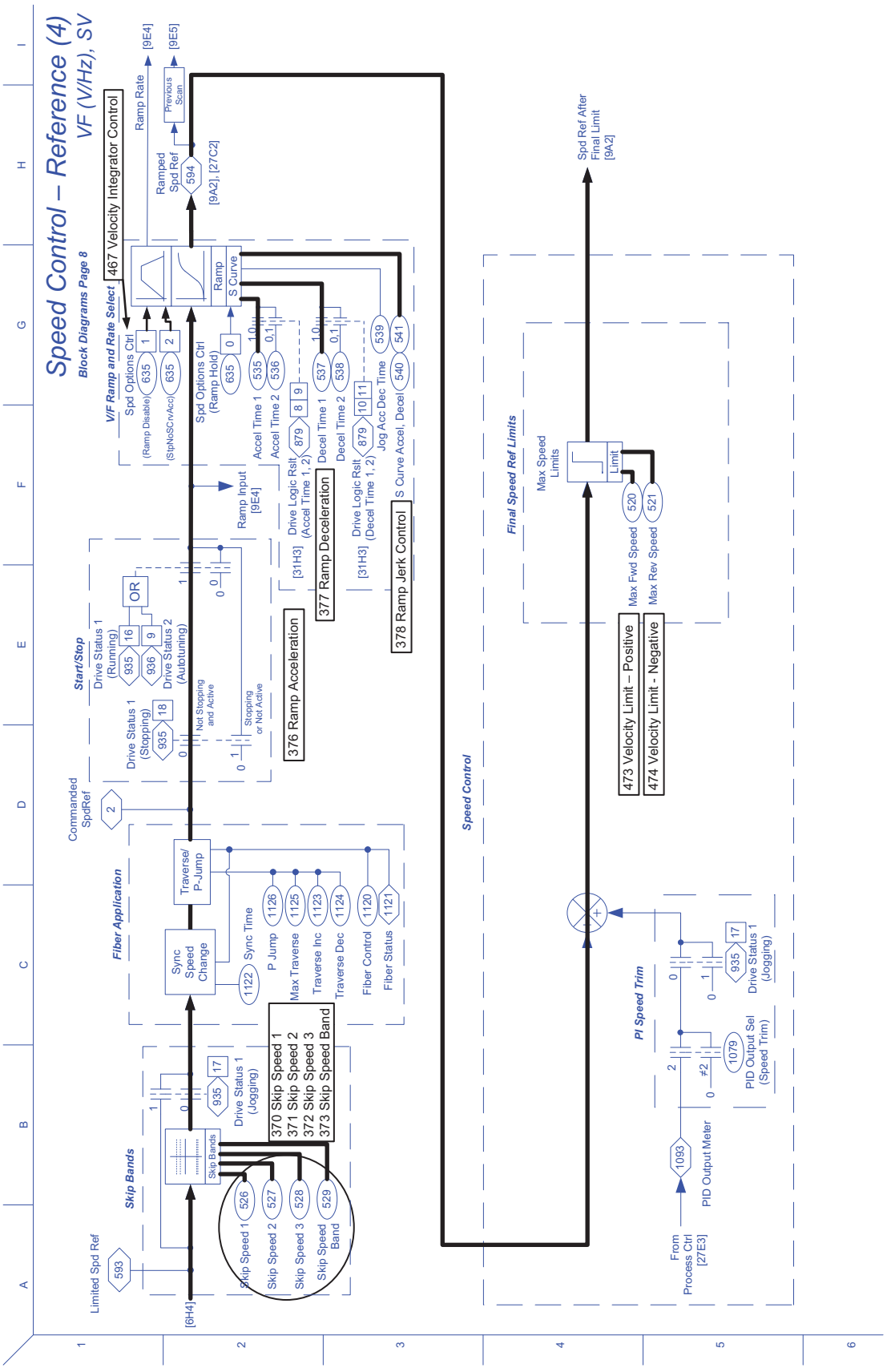
Speed Control Reference (Sheet 2)



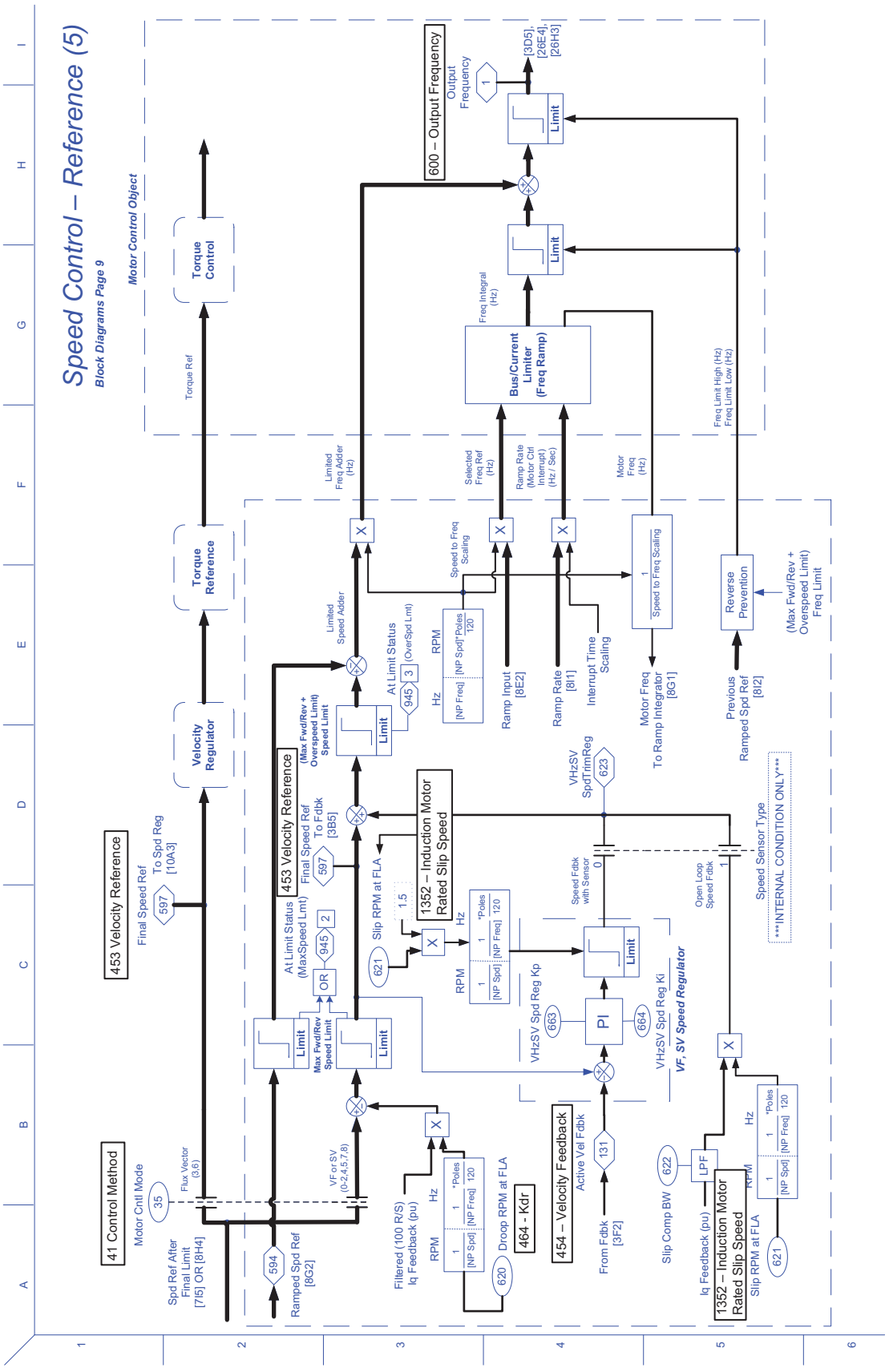
Speed Control Reference (Sheet 3)



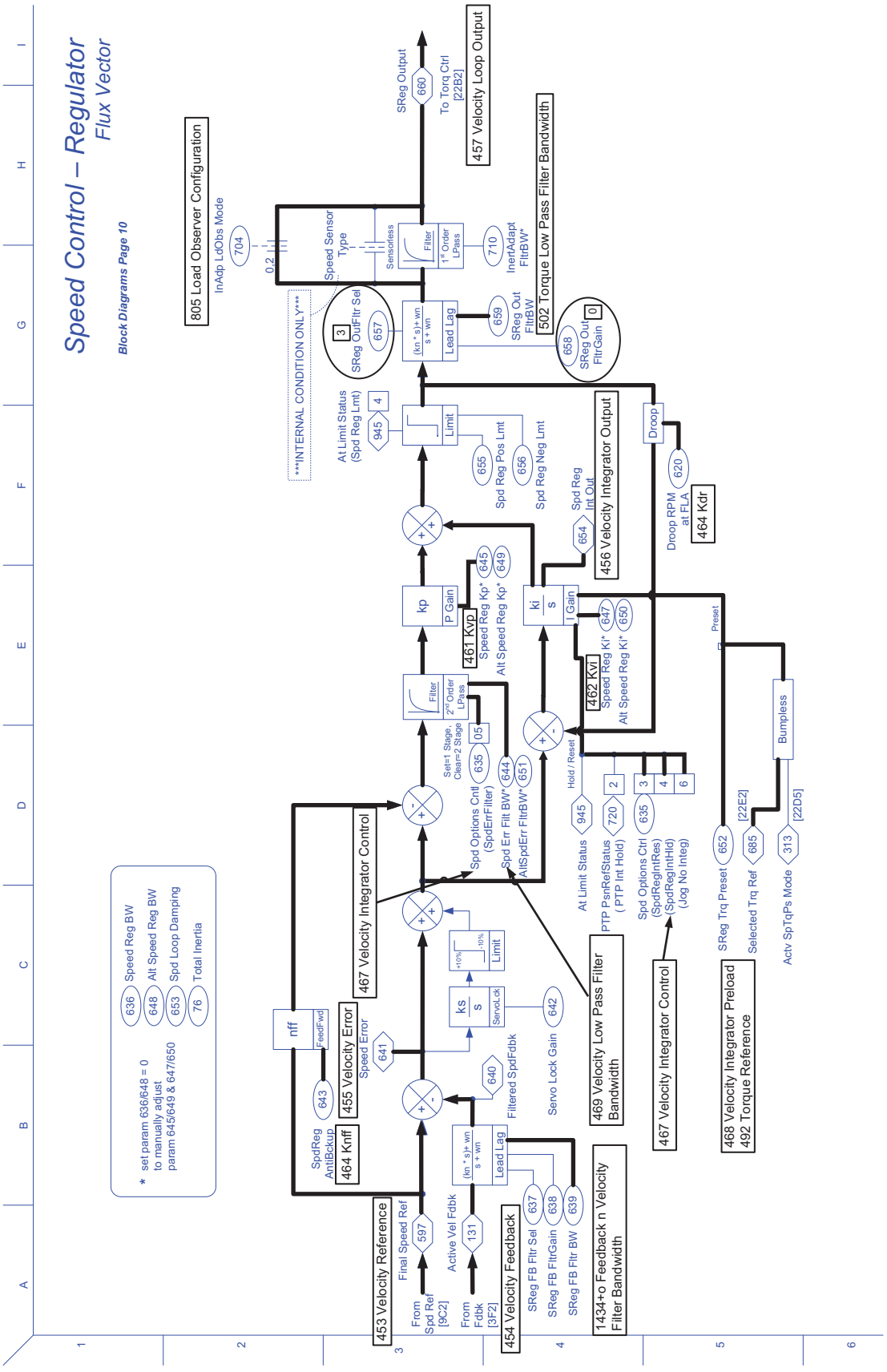
Speed Control Reference (Sheet 4)



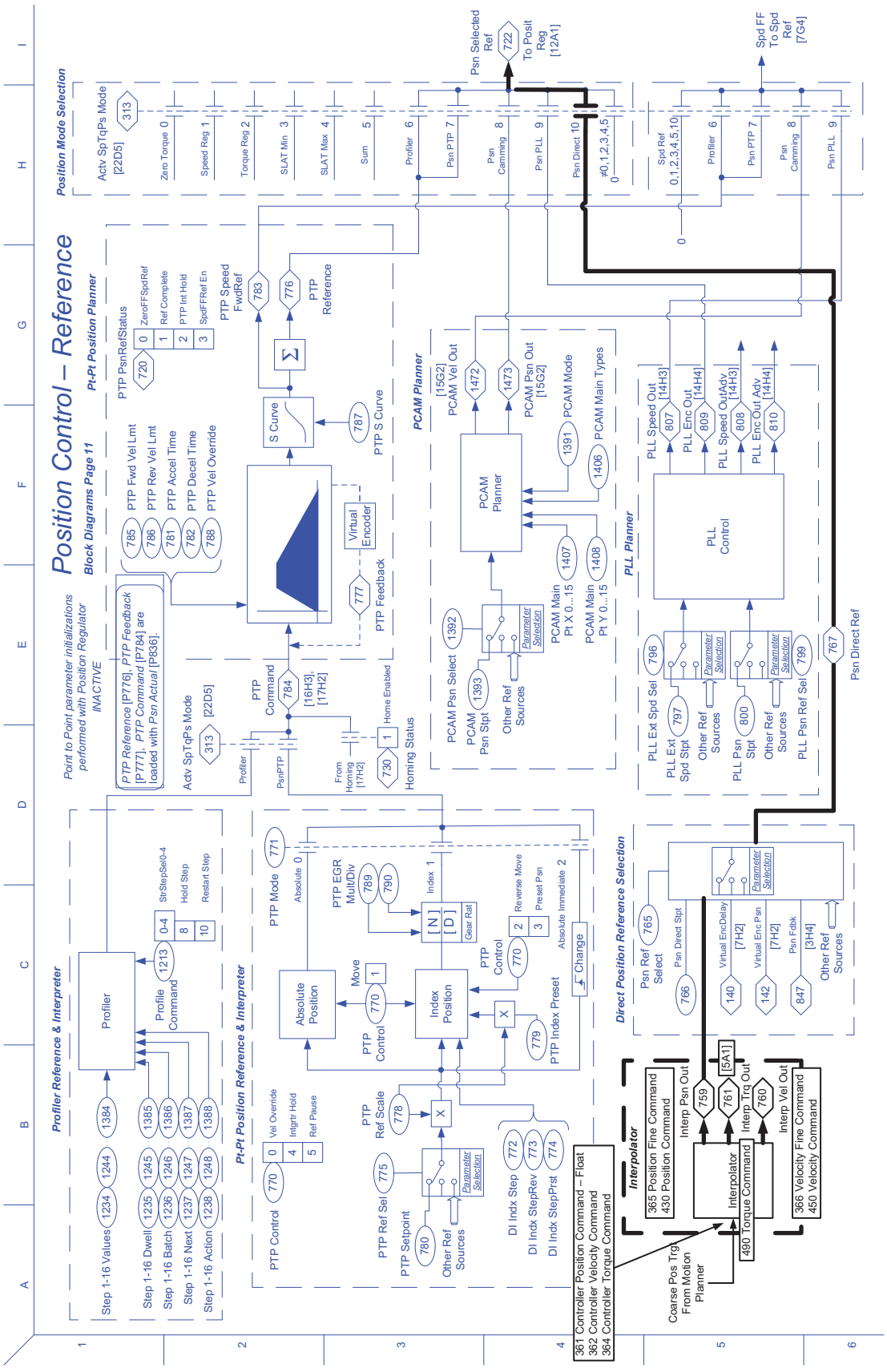
Speed Control Reference (Sheet 5)



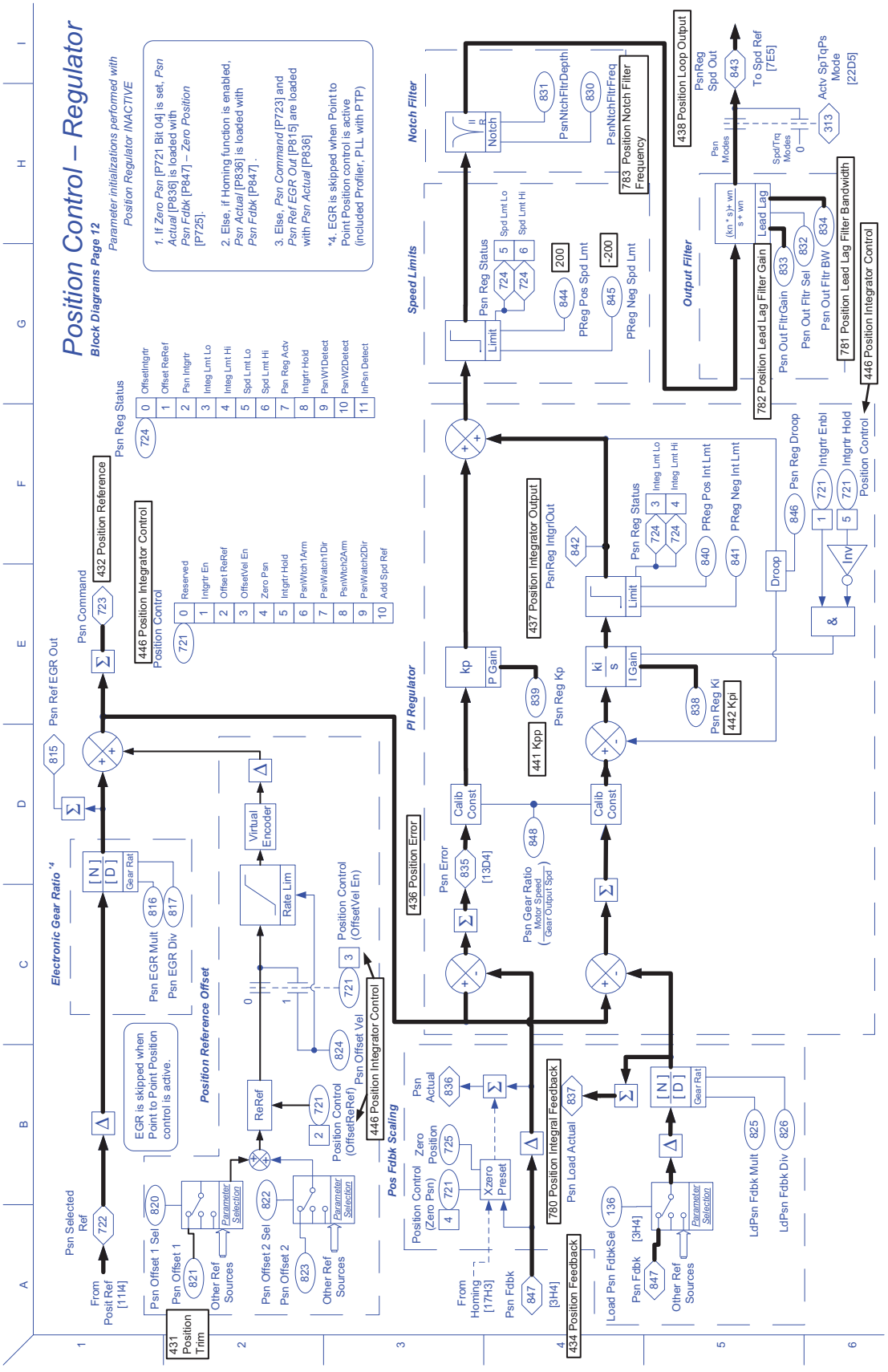
Speed Control - Regulator (Flux Vector)



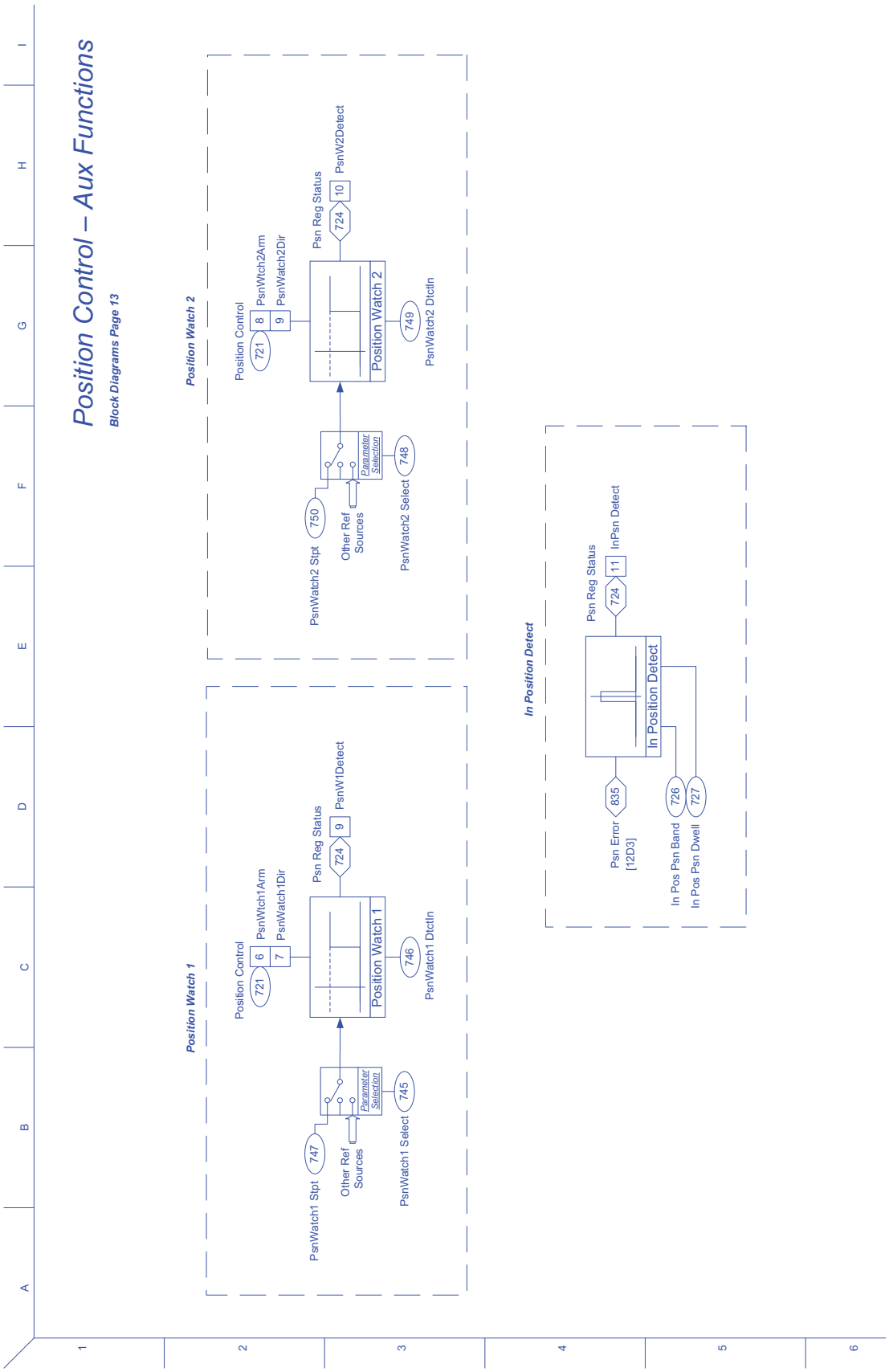
Position Control - Reference



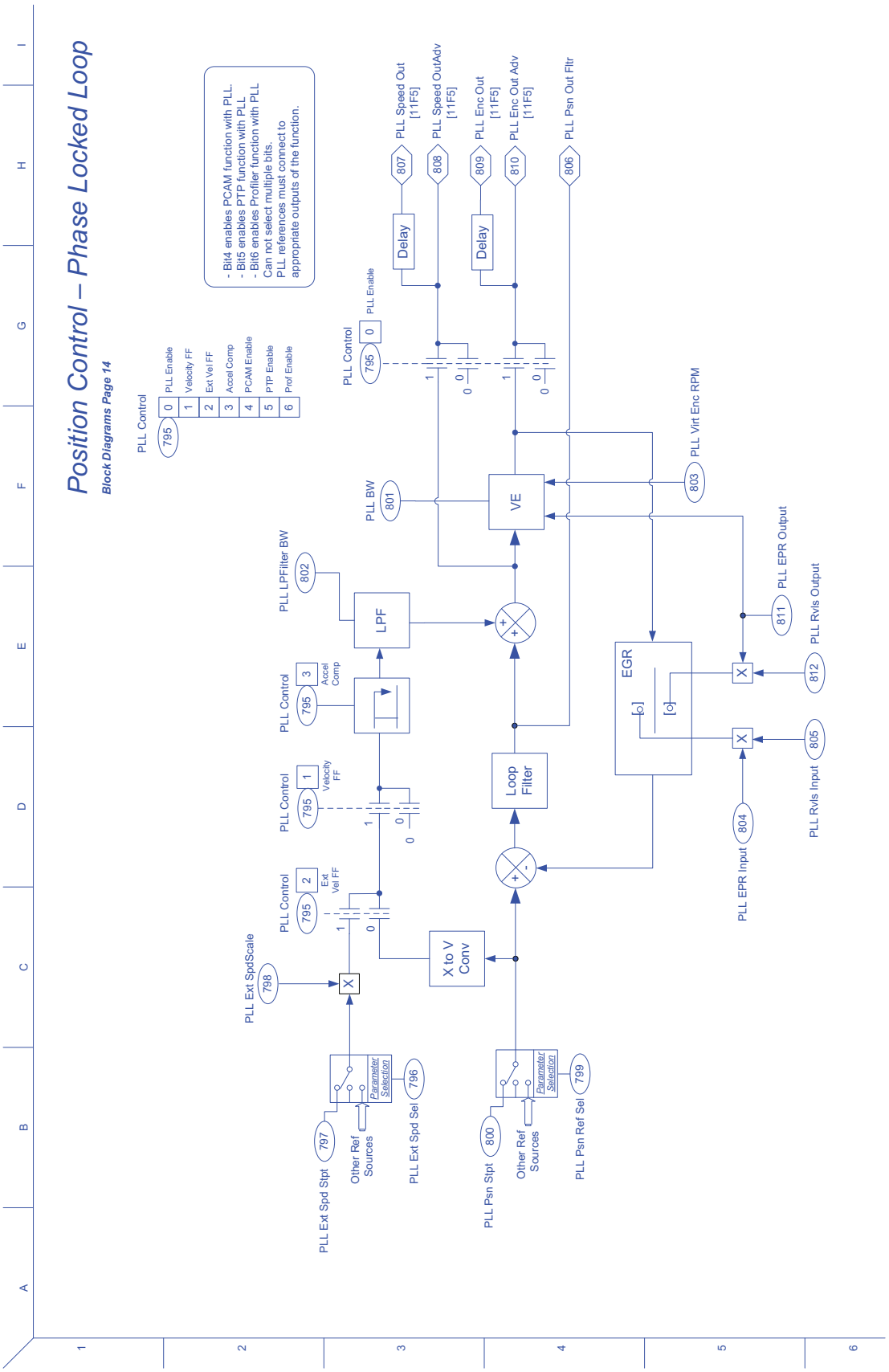
Position Control - Regulator



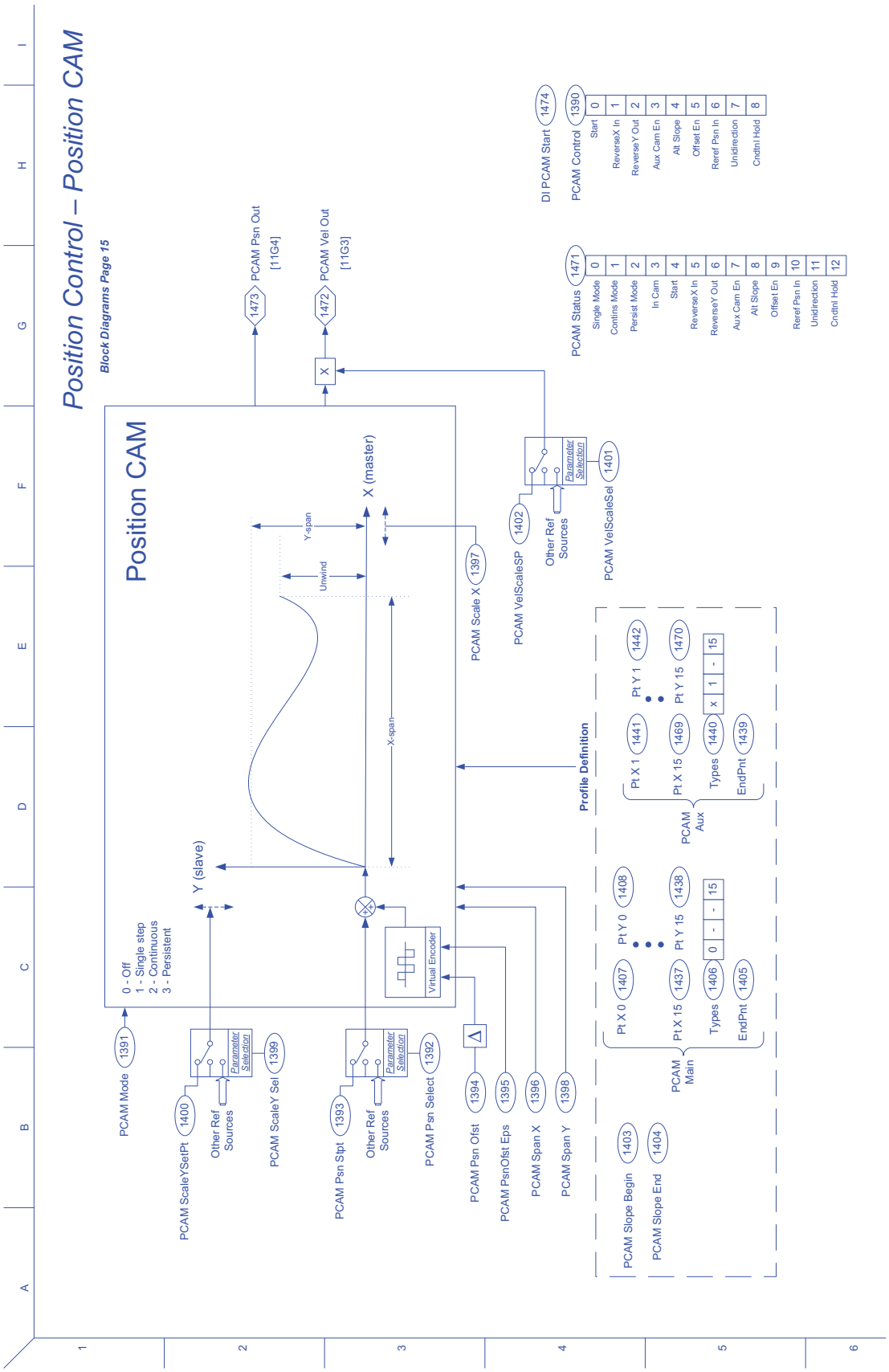
Position Control - Aux Functions



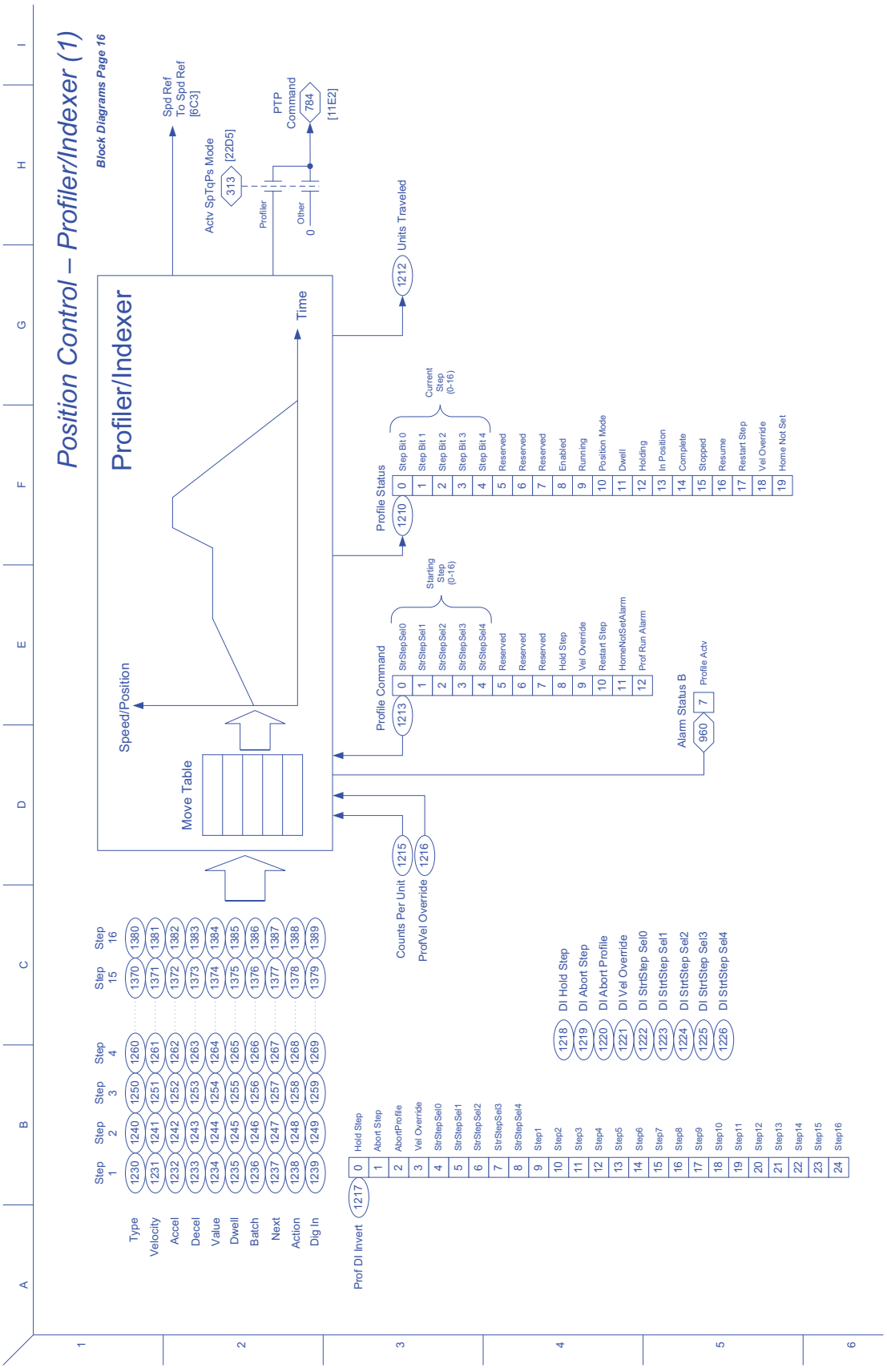
Position Control - Phase Locked Loop


Position Control – Phase Locked Loop
Block Diagrams Page 14
- Bit4 enables PCAM function with PLL.
- Bit5 enables PTP function with PLL
- Bit6 enables Profiler function with PLL
Can not select multiple bits.
PLL references must connect to appropriate outputs of the function.
PLL Control 795
0 PLL Enable
1 Velocity FF
2 Ext Vel FF
3 Accel Comp
4 PCAM Enable
5 PTP Enable
6 Prof Enable
PLL Speed Out [11F5] 807
PLL Speed OutAdv [11F5] 808
PLL Enc Out [11F5] 809
PLL Enc Out Adv [11F5] 810
PLL Psn Out Fltr 806
Delay
PLL BW 801
VE
PLL Virt Enc RPM 803
PLL LPFilter BW 802
LPF
Accel Comp
Velocity FF
Ext Vel FF
X to V Conv
Loop Filter
EGR
PLL EPR Output 811
PLL Rvls Output 812
PLL Ext SpdScale 798
PLL Ext Spd Stpt 797
Other Ref Sources
Parameter Selection
PLL Ext Spd Sel 796
PLL Psn Stpt 800
PLL Psn Ref Sel 799
PLL EPR Input 804
PLL Rvls Input 805

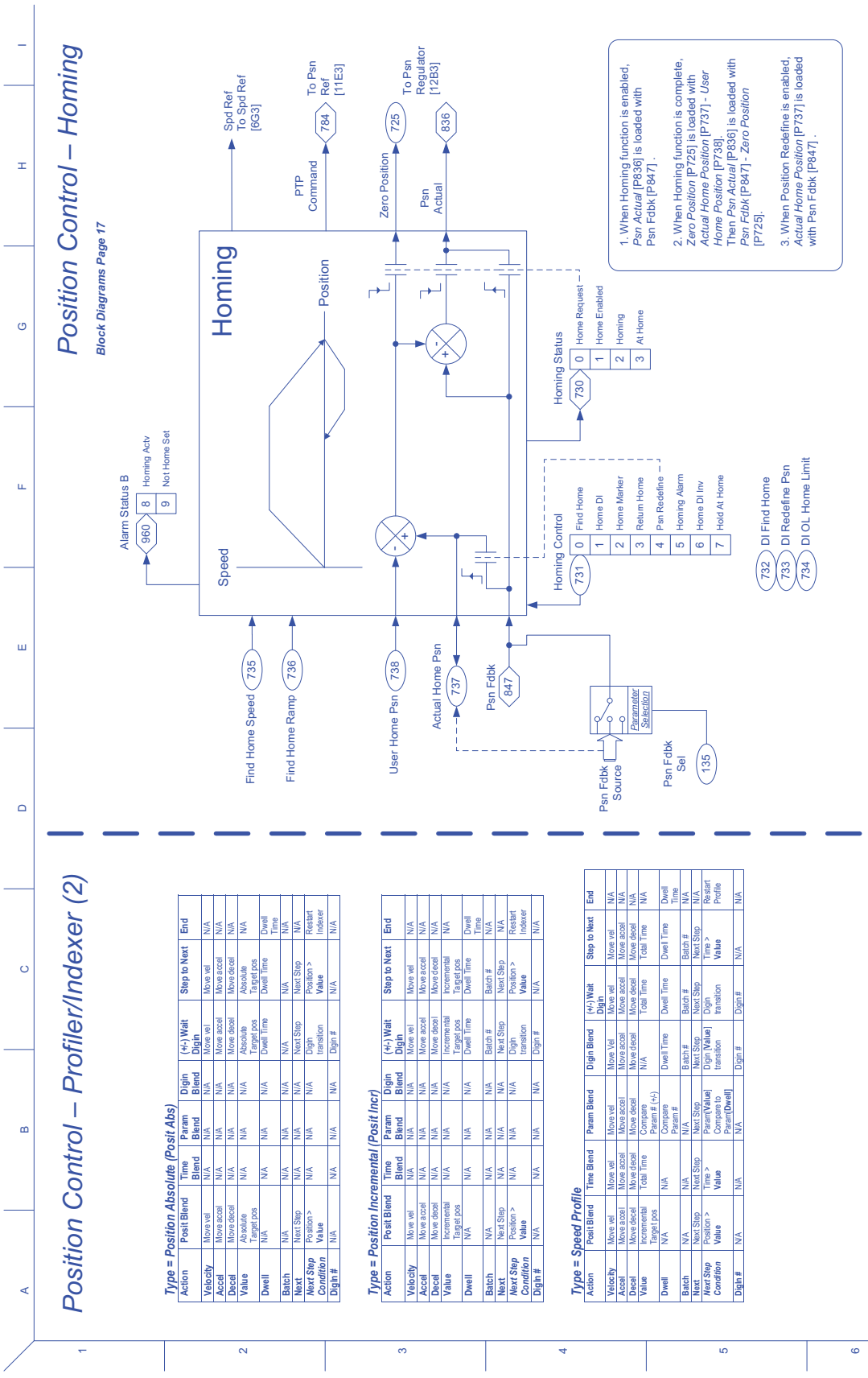
Position Control - Position CAM



Position Control - Profiler/Indexer (Sheet 1)



Position Control - Profiler/Indexer (Sheet 2) / Position Control - Homing


Position Control – Profiler/Indexer (2)
Position Control – Homing
Block Diagrams Page 17
Type = Position Absolute (Posit Abs)
Type = Position Incremental (Posit Incr)
Type = Speed Profile
Homing
Speed
Position
Alarm Status B
960
8 Homing Activ
9 Not Home Set
Find Home Speed 735
Find Home Ramp 736
User Home Psn 738
Actual Home Psn 737
Psn Fdbk 847
Psn Fdbk Source
Parameter Selection
Psn Fdbk Sel 135
Homing Control 731
0 Find Home
1 Home DI
2 Home Marker
3 Return Home
4 Psn Redefine
5 Homing Alarm
6 Home DI Inv
7 Hold At Home
DI Find Home 732
DI Redefine Psn 733
DI OL Home Limit 734
Homing Status 730
0 Home Request
1 Home Enabled
2 Homing
3 At Home
Spd Ref To Spd Ref [6G3]
PTP Command
To Psn Ref [11E3]
784
Zero Position
725
To Psn Regulator [12B3]
Psn Actual
836
1. When Homing function is enabled, Psn Actual [P836] is loaded with Psn Fdbk [P847] .
2. When Homing function is complete, Zero Position [P725] is loaded with Actual Home Position [P737] - User Home Position [P738]. Then Psn Actual [P836] is loaded with Psn Fdbk [P847] - Zero Position [P725].
3. When Position Redefine is enabled, Actual Home Position [P737] is loaded with Psn Fdbk [P847] .

Type = Position Absolute (Posit Abs)

Action	Posit Blend	Time Blend	Param Blend	Digin Blend	(+/-) Wait Digin	Step to Next	End
Velocity	Move vel	N/A	N/A	N/A	Move vel	Move vel	N/A
Accel	Move accel	N/A	N/A	N/A	Move accel	Move accel	N/A
Decel	Move decel	N/A	N/A	N/A	Move decel	Move decel	N/A
Value	Absolute Target pos	N/A	N/A	N/A	Absolute Target pos	Absolute Target pos	N/A
Dwell	N/A	N/A	N/A	N/A	Dwell Time	Dwell Time	Dwell Time
Batch	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Next	Next Step	N/A	N/A	N/A	Next Step	Next Step	N/A
Next Step Condition	Position > **Value**	N/A	N/A	N/A	Digin transition	Position > **Value**	Restart Indexer
Digin #	N/A	N/A	N/A	N/A	Digin #	N/A	N/A

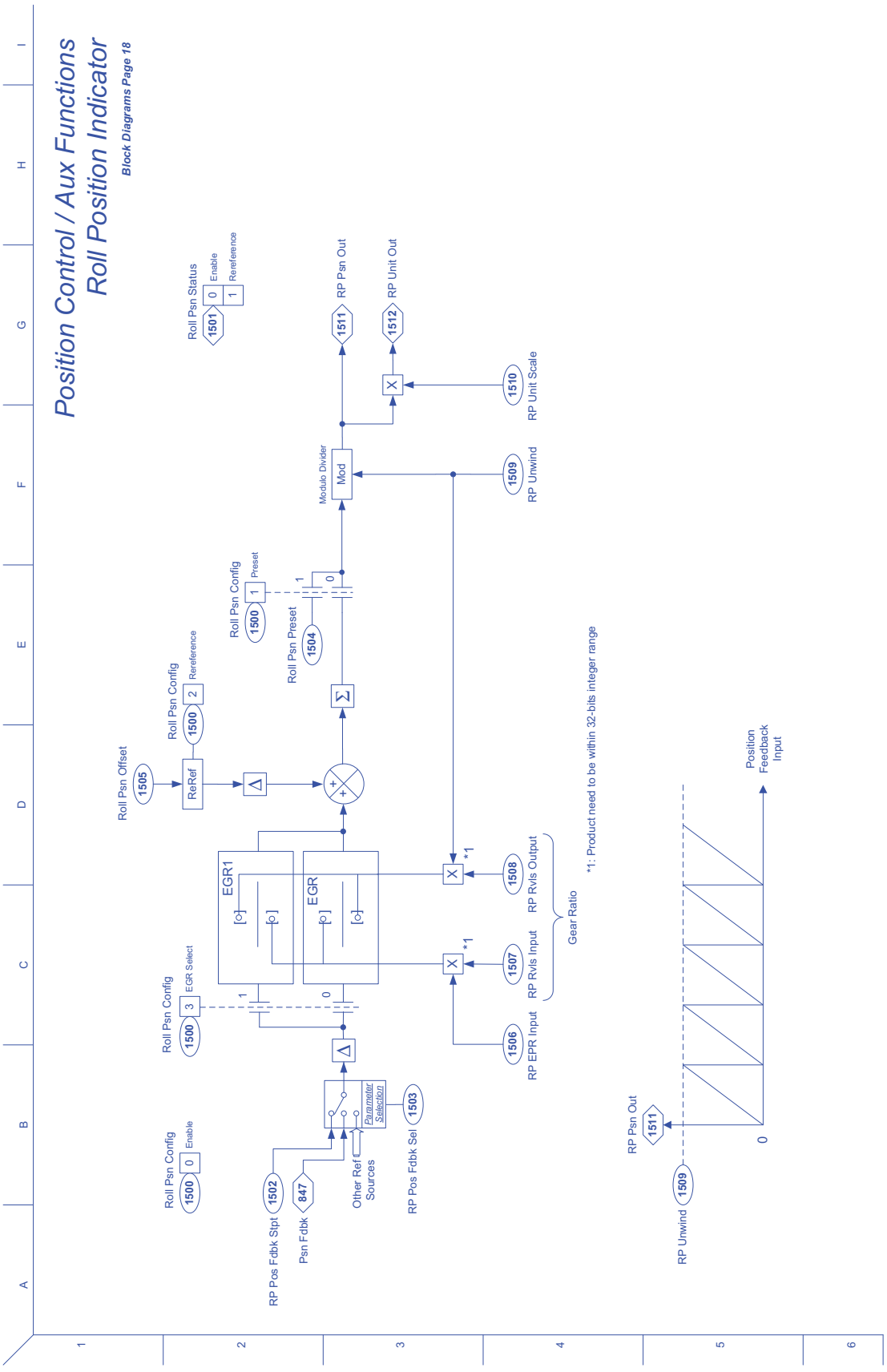
Type = Position Incremental (Posit Incr)

Action	Posit Blend	Time Blend	Param Blend	Digin Blend	(+/-) Wait Digin	Step to Next	End
Velocity	Move vel	N/A	N/A	N/A	Move vel	Move vel	N/A
Accel	Move accel	N/A	N/A	N/A	Move accel	Move accel	N/A
Decel	Move decel	N/A	N/A	N/A	Move decel	Move decel	N/A
Value	Incremental Target pos	N/A	N/A	N/A	Incremental Target pos	Incremental Target pos	N/A
Dwell	N/A	N/A	N/A	N/A	Dwell Time	Dwell Time	Dwell Time
Batch	N/A	N/A	N/A	N/A	Batch #	Batch #	N/A
Next	Next Step	N/A	N/A	N/A	Next Step	Next Step	N/A
Next Step Condition	Position > **Value**	N/A	N/A	N/A	Digin transition	Position > **Value**	Restart Indexer
Digin #	N/A	N/A	N/A	N/A	Digin #	N/A	N/A

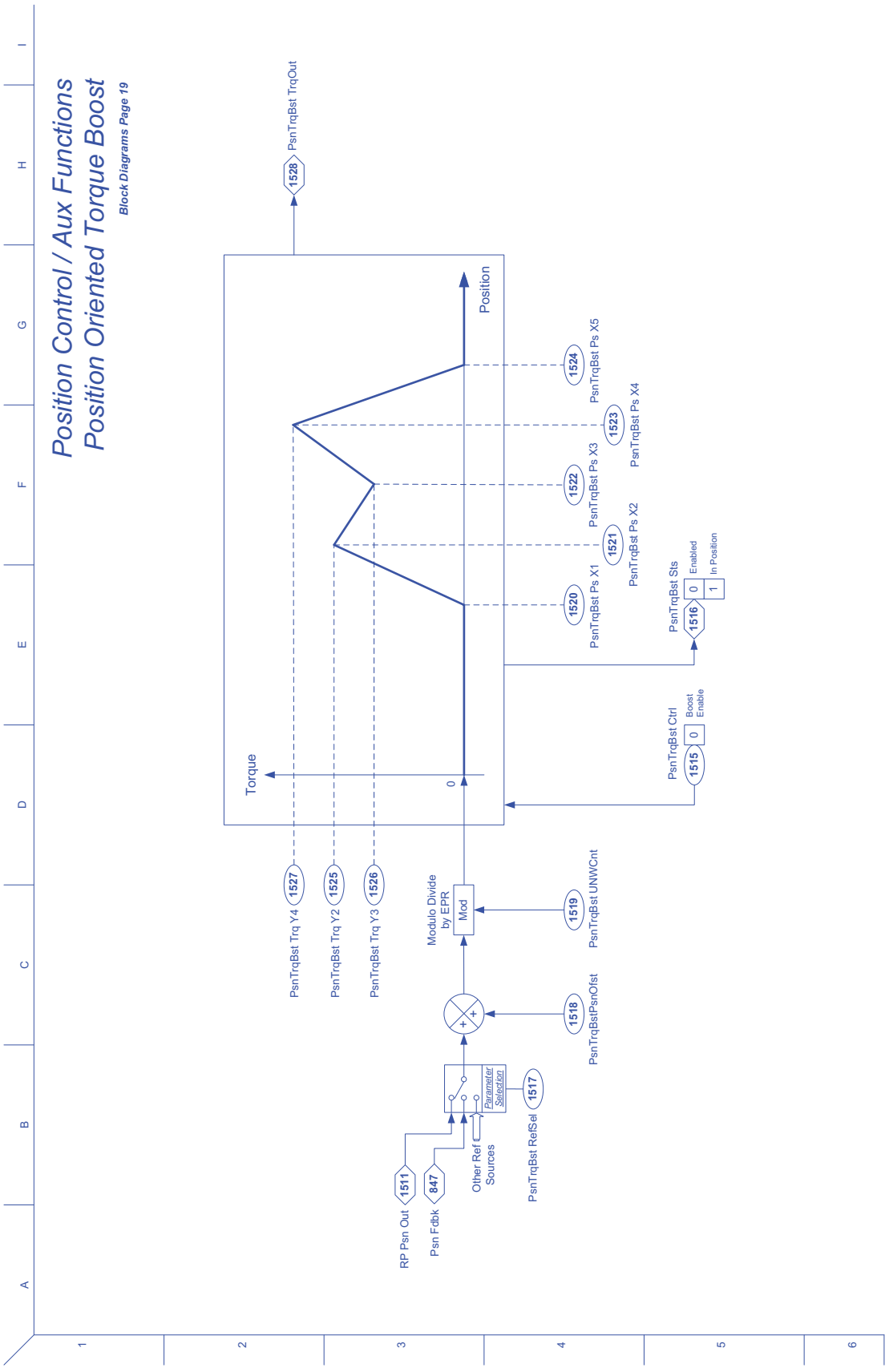
Type = Speed Profile

Action	Posit Blend	Time Blend	Param Blend	Digin Blend	(+/-) Wait Digin	Step to Next	End
Velocity	Move vel	Move vel	Move vel	Move Vel	Move vel	Move vel	N/A
Accel	Move accel	Move accel	Move accel	Move accel	Move accel	Move accel	N/A
Decel	Move decel	Move decel	Move decel	Move decel	Move decel	Move decel	N/A
Value	Incremental Target pos	Total Time	Compare Param #	N/A	Total Time	Total Time	N/A
Dwell	N/A	N/A	Compare Param #	Dwell Time	Dwell Time	Dwell Time	Dwell Time
Batch	N/A	N/A	N/A	Batch #	Batch #	Batch #	N/A
Next	Next Step	Next Step	Next Step	Next Step	Next Step	Next Step	N/A
Next Step Condition	Position > **Value**	Time > **Value**	Param[**Value**] Compare to Param[**Dwell**]	Digin [**Value**] transition	Digin transition	Time > **Value**	Restart Profile
Digin #	N/A	N/A	N/A	Digin #	Digin #	N/A	N/A

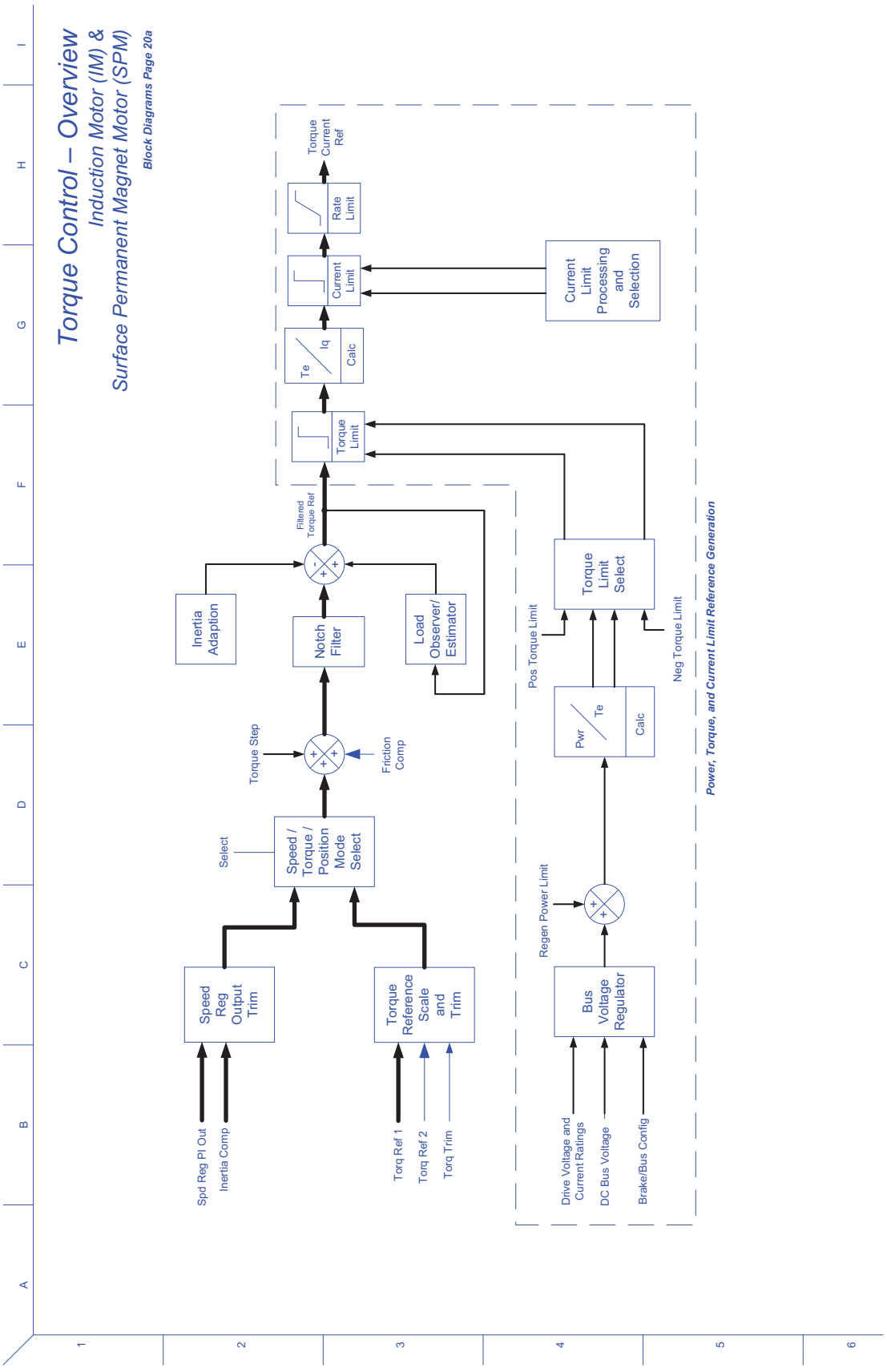
Position Control / Aux Functions, Roll Position Indicator



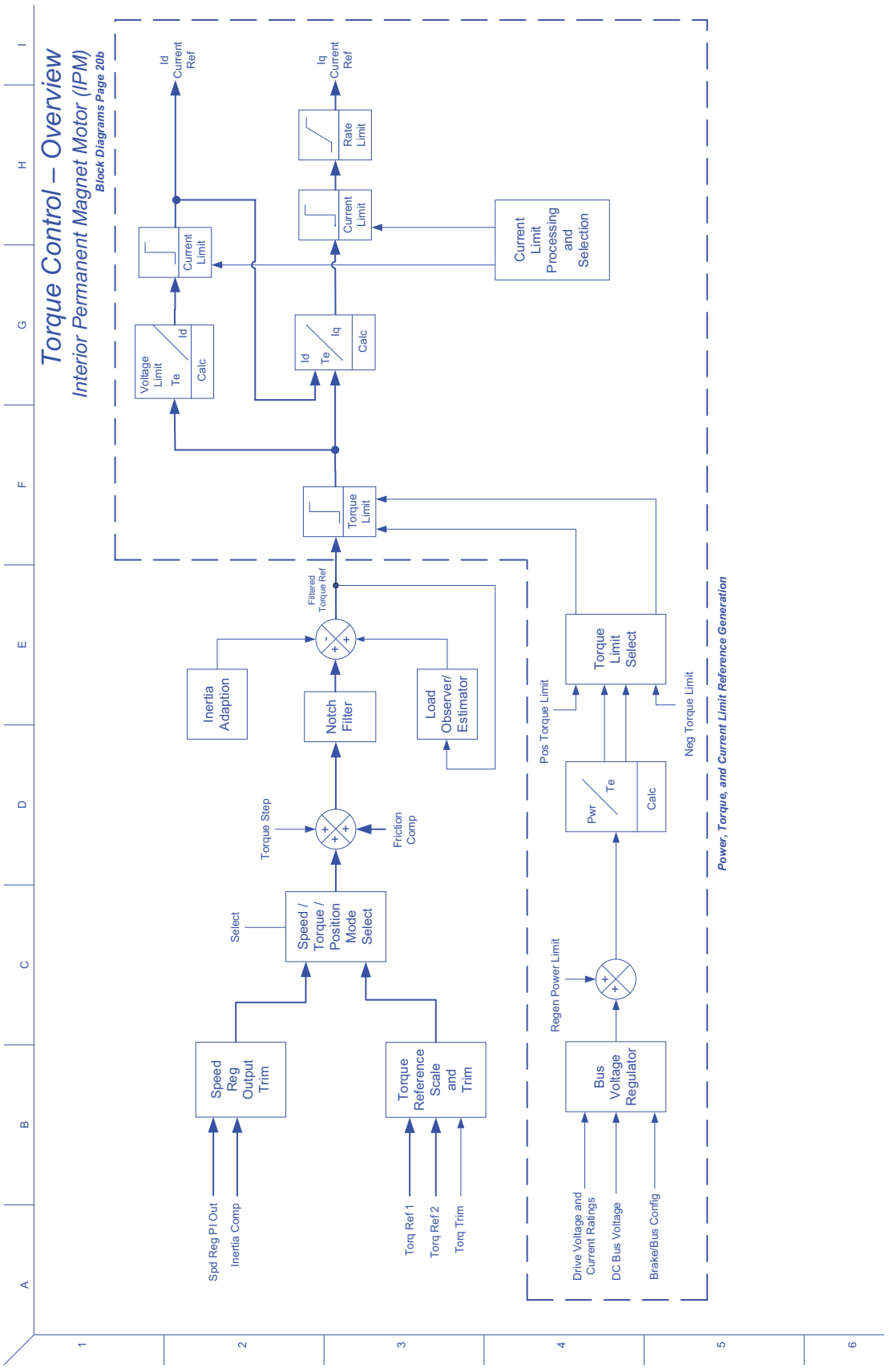
Position Control / Aux Functions, Position Oriented Torque Boost



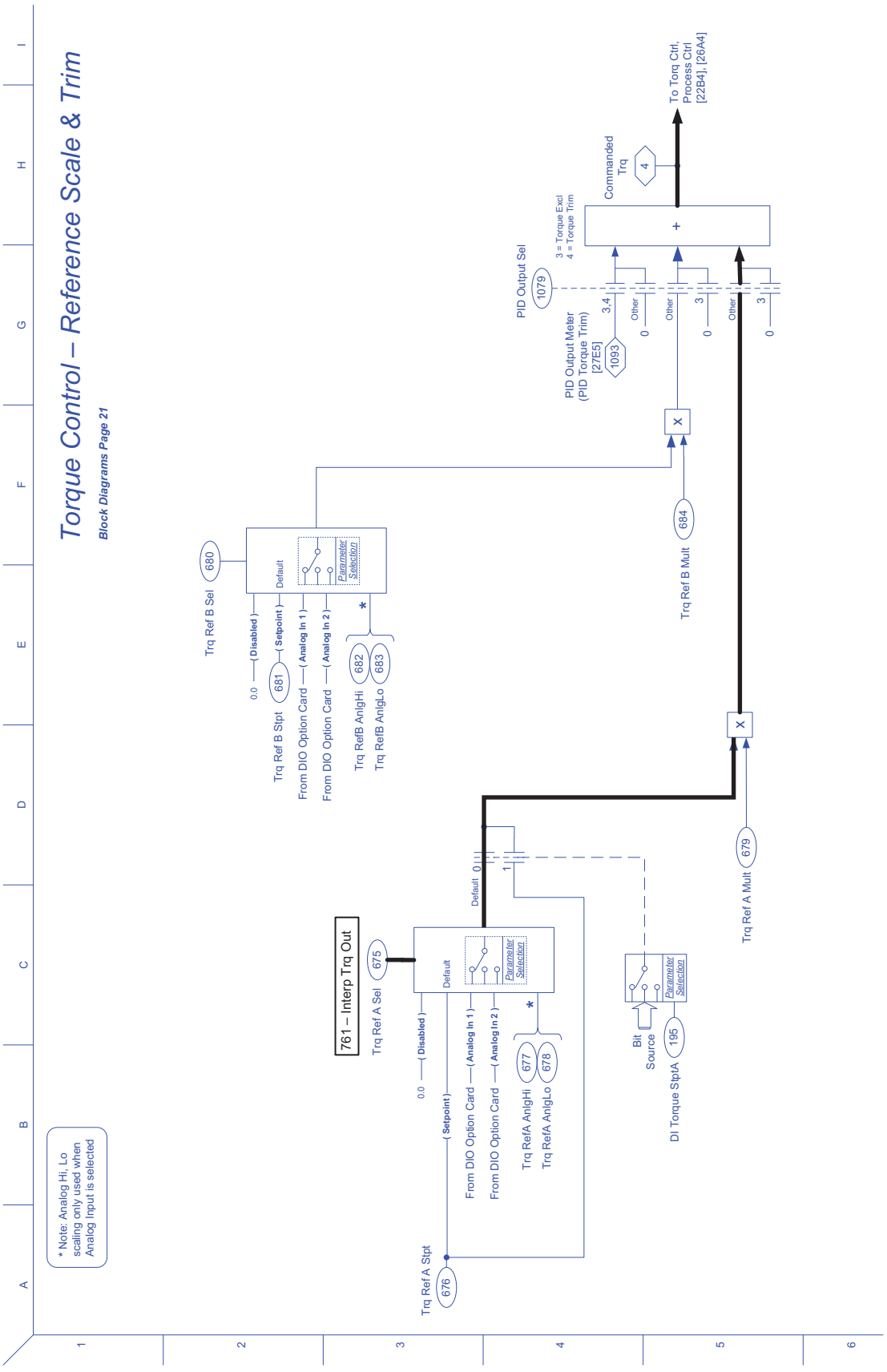
Torque Control Overview - Induction Motor and Surface Permanent Magnet Motor



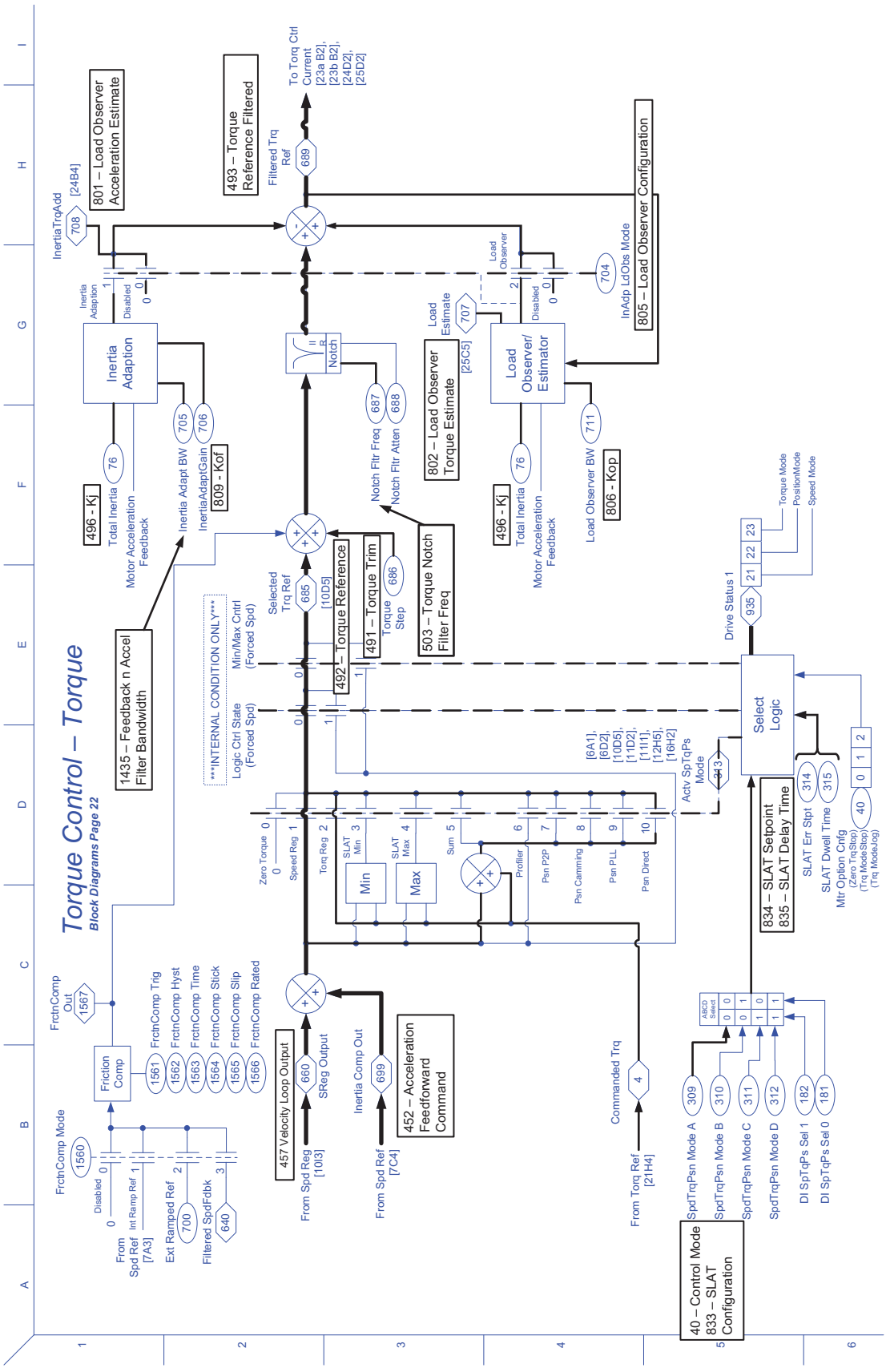
Torque Control Overview - Interior Permanent Magnet Motor



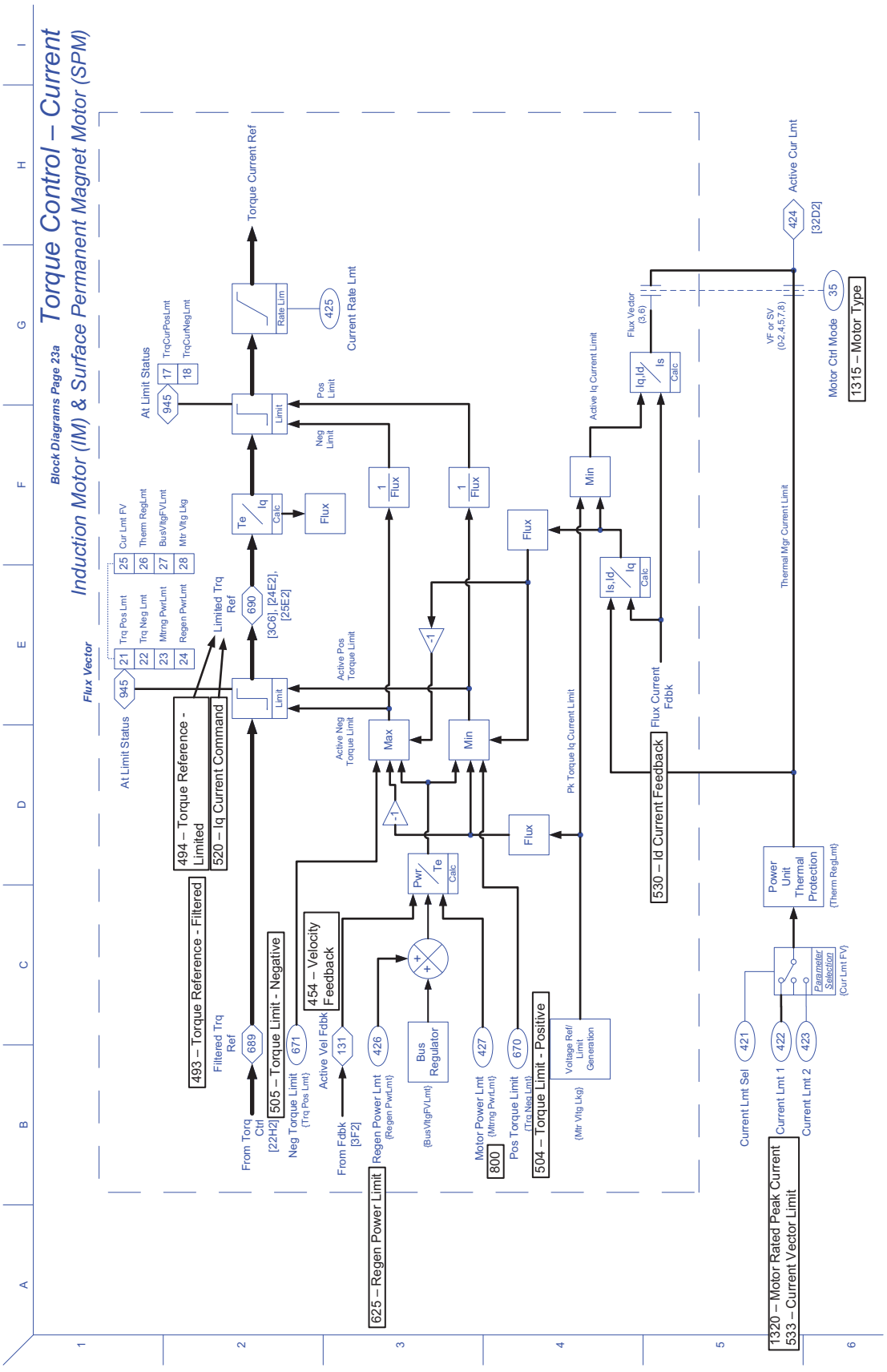
Torque Control - Reference Scale and Trim



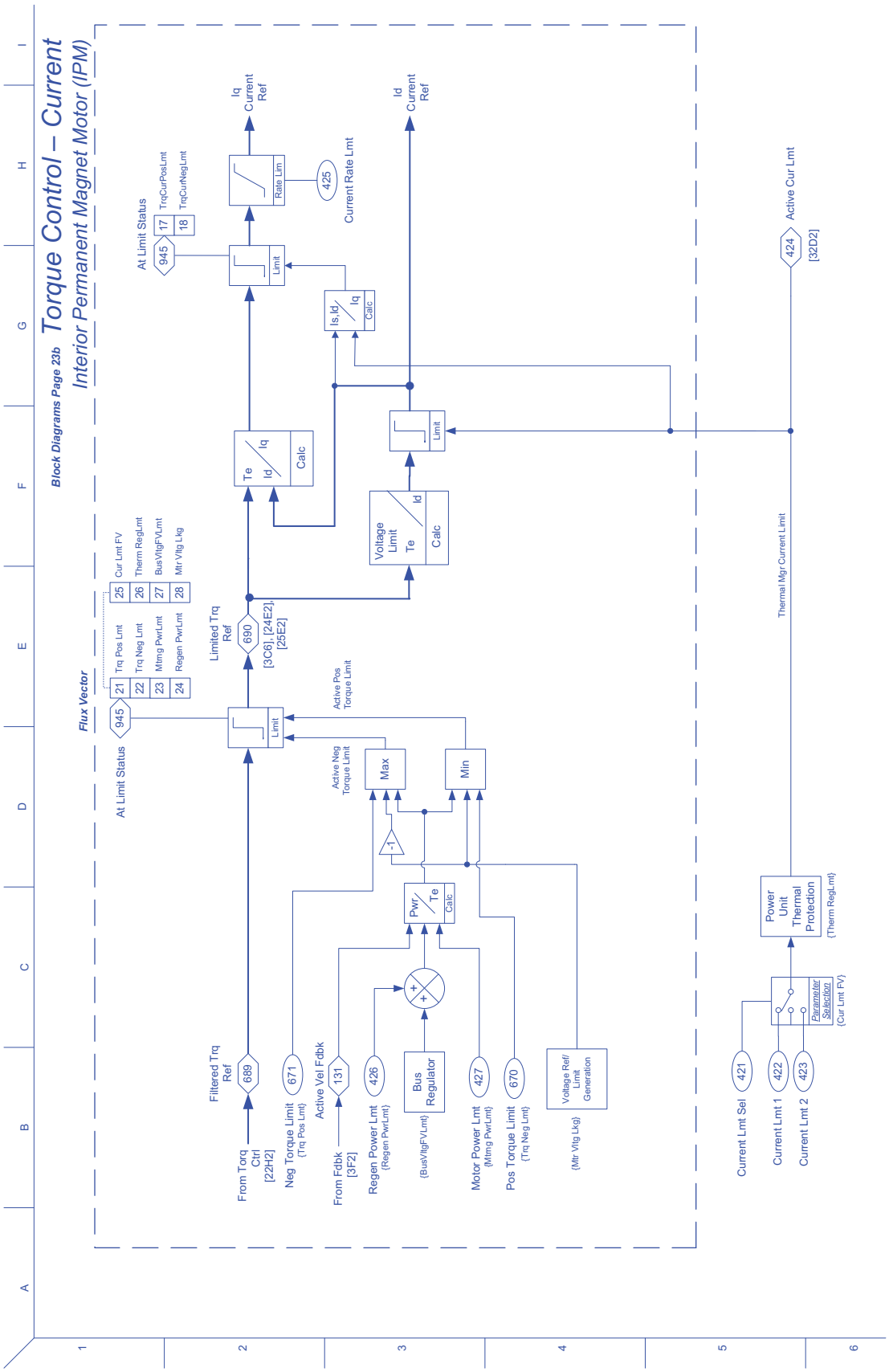
Torque Control - Torque



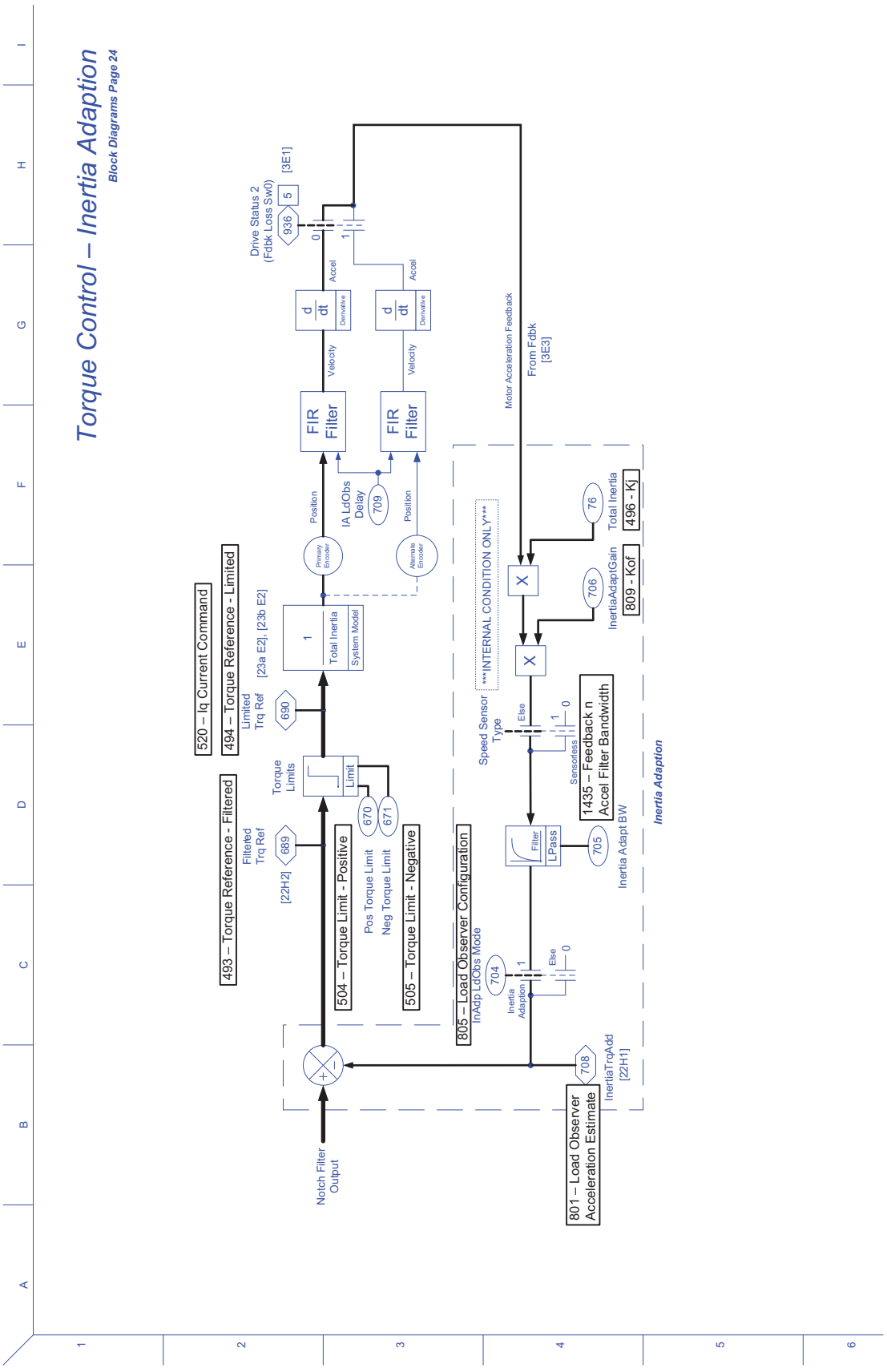
Torque Control - Current, Induction Motor and Surface Permanent Magnet Motor



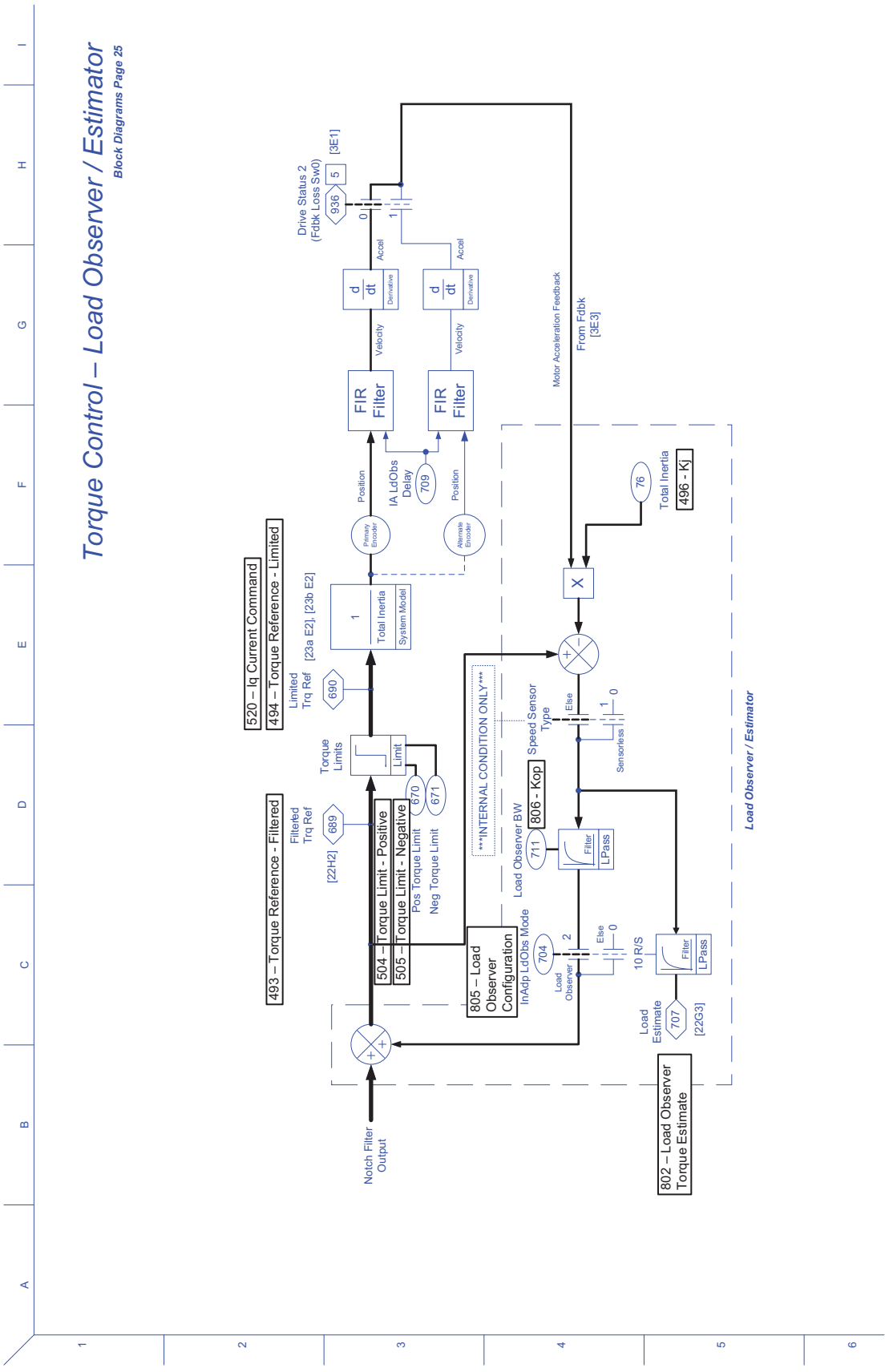
Torque Control - Current, Interior Permanent Magnet Motor



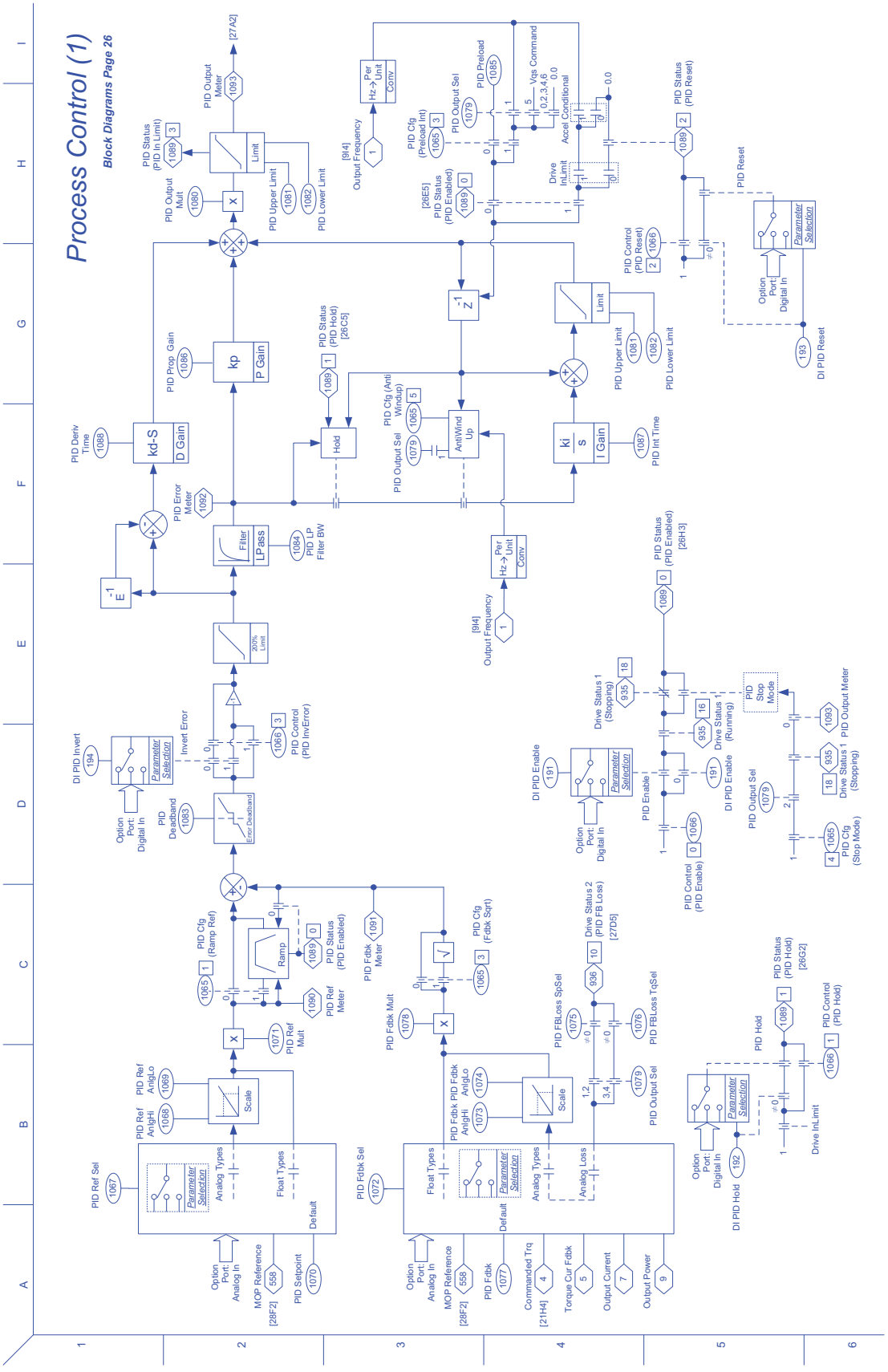
Torque Control - Inertia Adaption



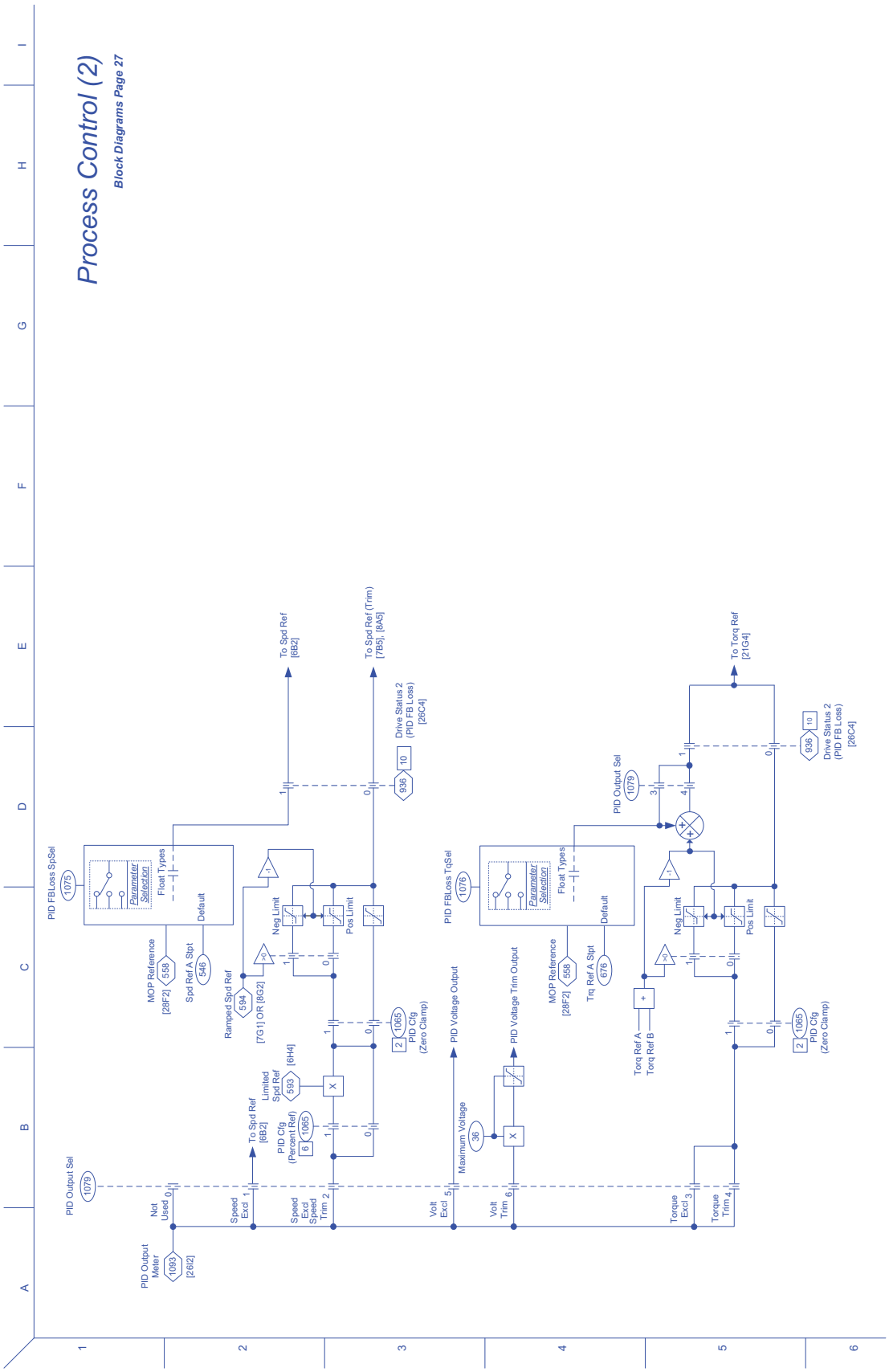
Torque Control - Load Observer / Estimator



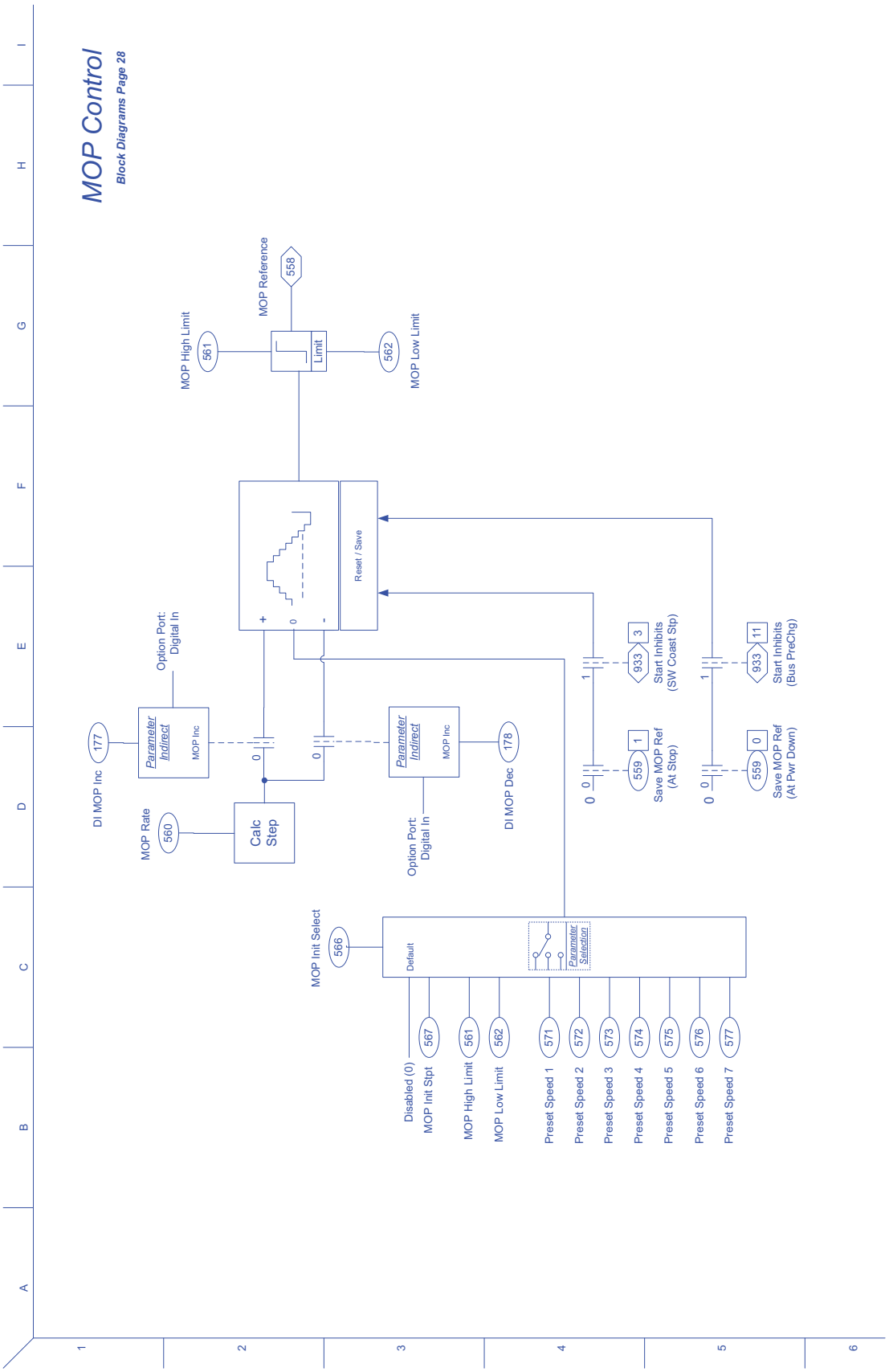
Process Control (Sheet 1)



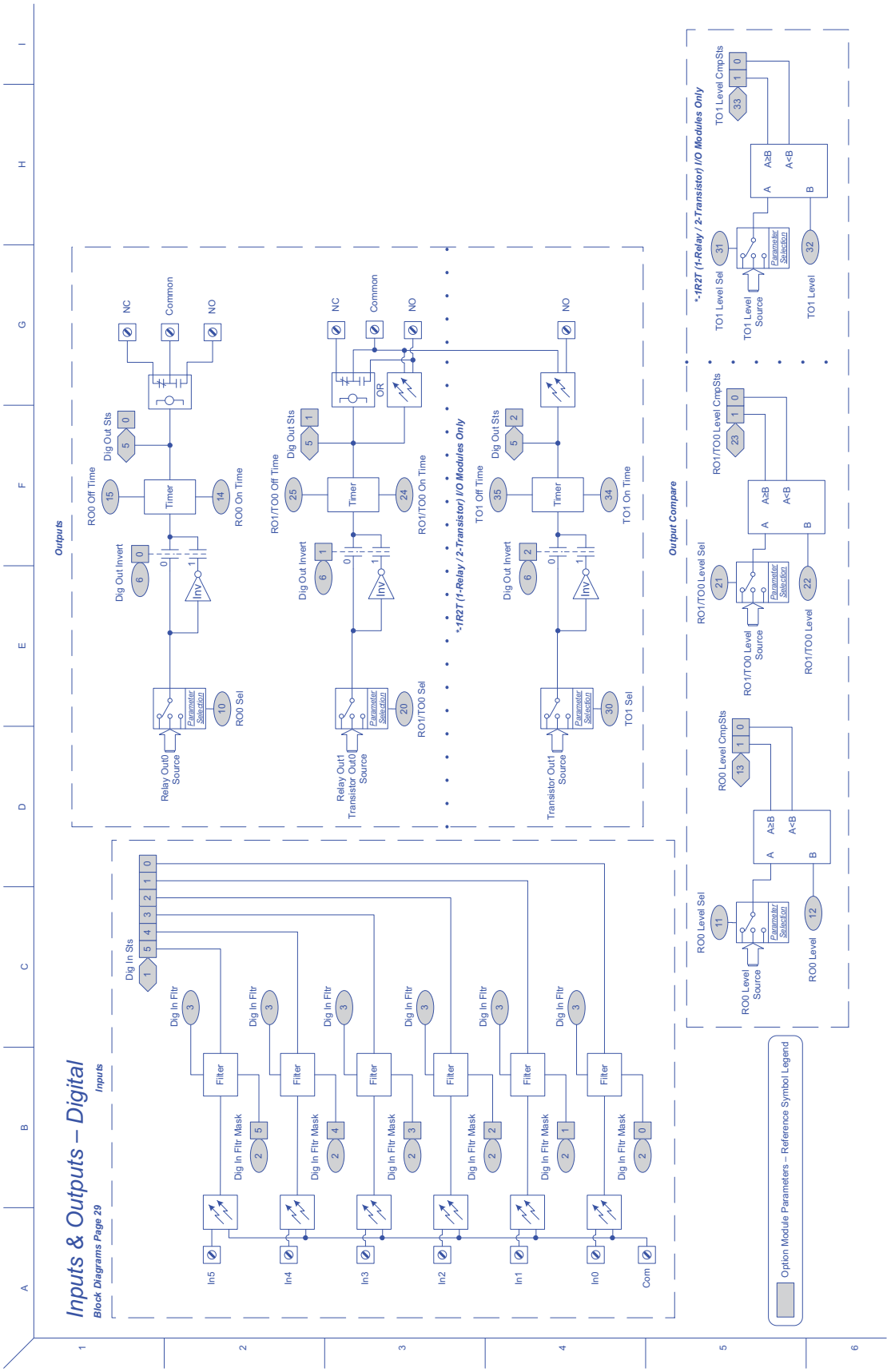
Process Control (Sheet 2)



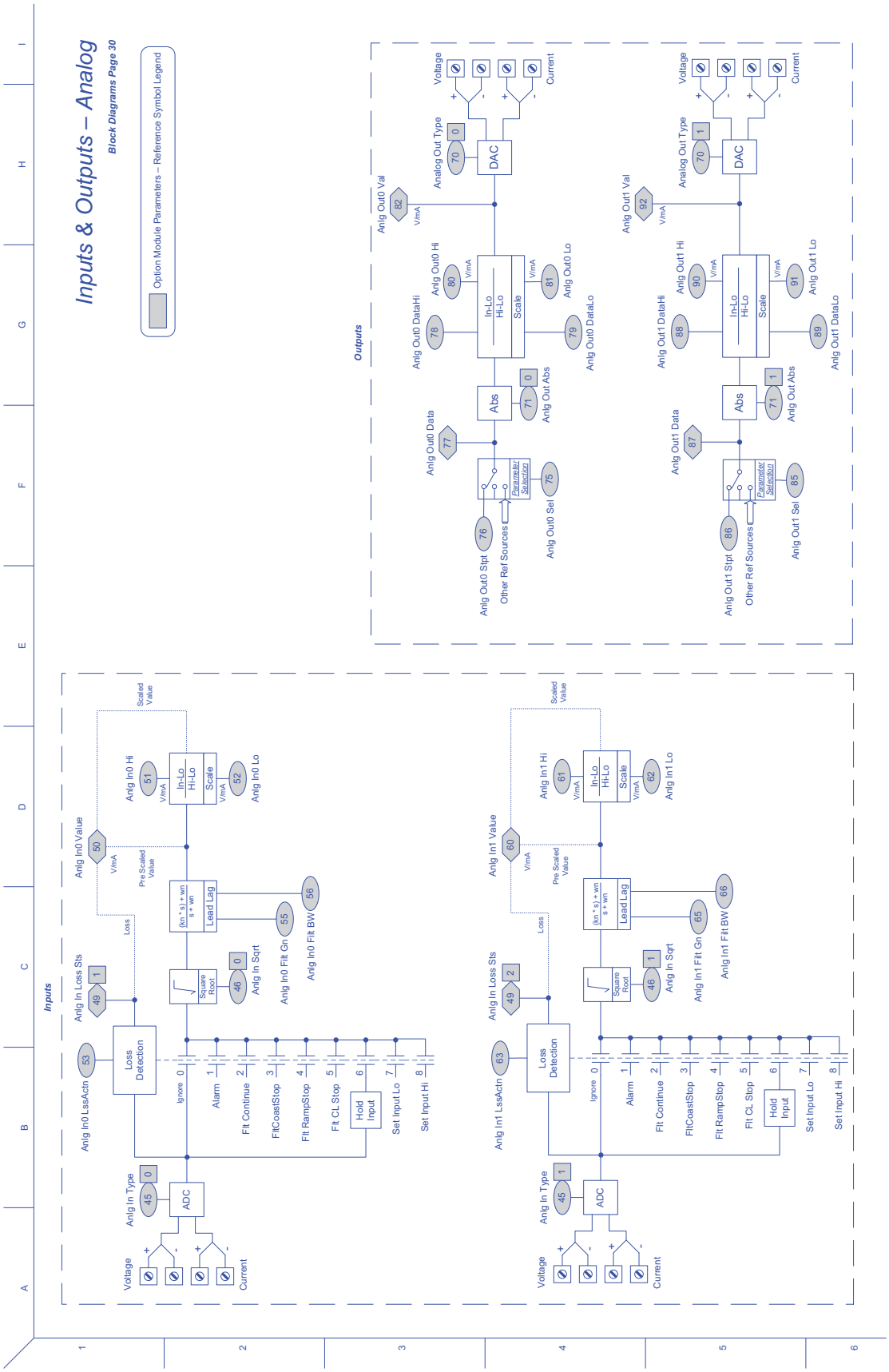
MOP Control


MOP Control
Block Diagrams Page 28
MOP Reference
558
MOP High Limit
561
Limit
562
MOP Low Limit
Reset / Save
Option Port:
Digital In
Parameter
Indirect
MOP Inc
177
DI MOP Inc
MOP Rate
560
Calc
Step
178
DI MOP Dec
933
3
Start Inhibits
(SW Coast Stp)
559
1
Save MOP Ref
(At Stop)
11
Start Inhibits
(Bus PreChg)
0
Save MOP Ref
(At Pwr Down)
MOP Init Select
566
Default
Parameter
Selection
Disabled (0)
567
MOP Init Stpt
MOP High Limit
MOP Low Limit
571
Preset Speed 1
572
Preset Speed 2
573
Preset Speed 3
574
Preset Speed 4
575
Preset Speed 5
576
Preset Speed 6
577
Preset Speed 7

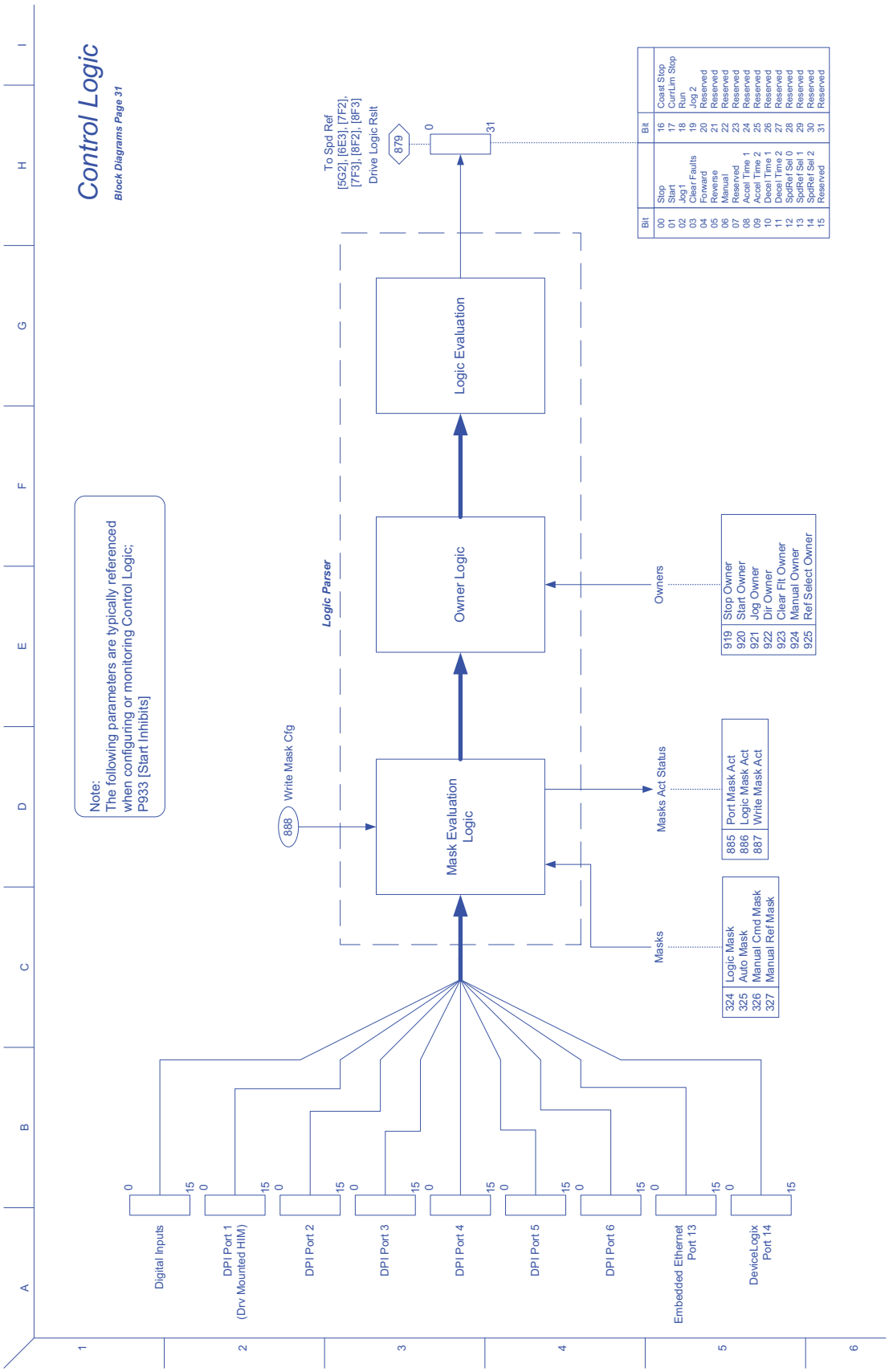
Inputs and Outputs - Digital



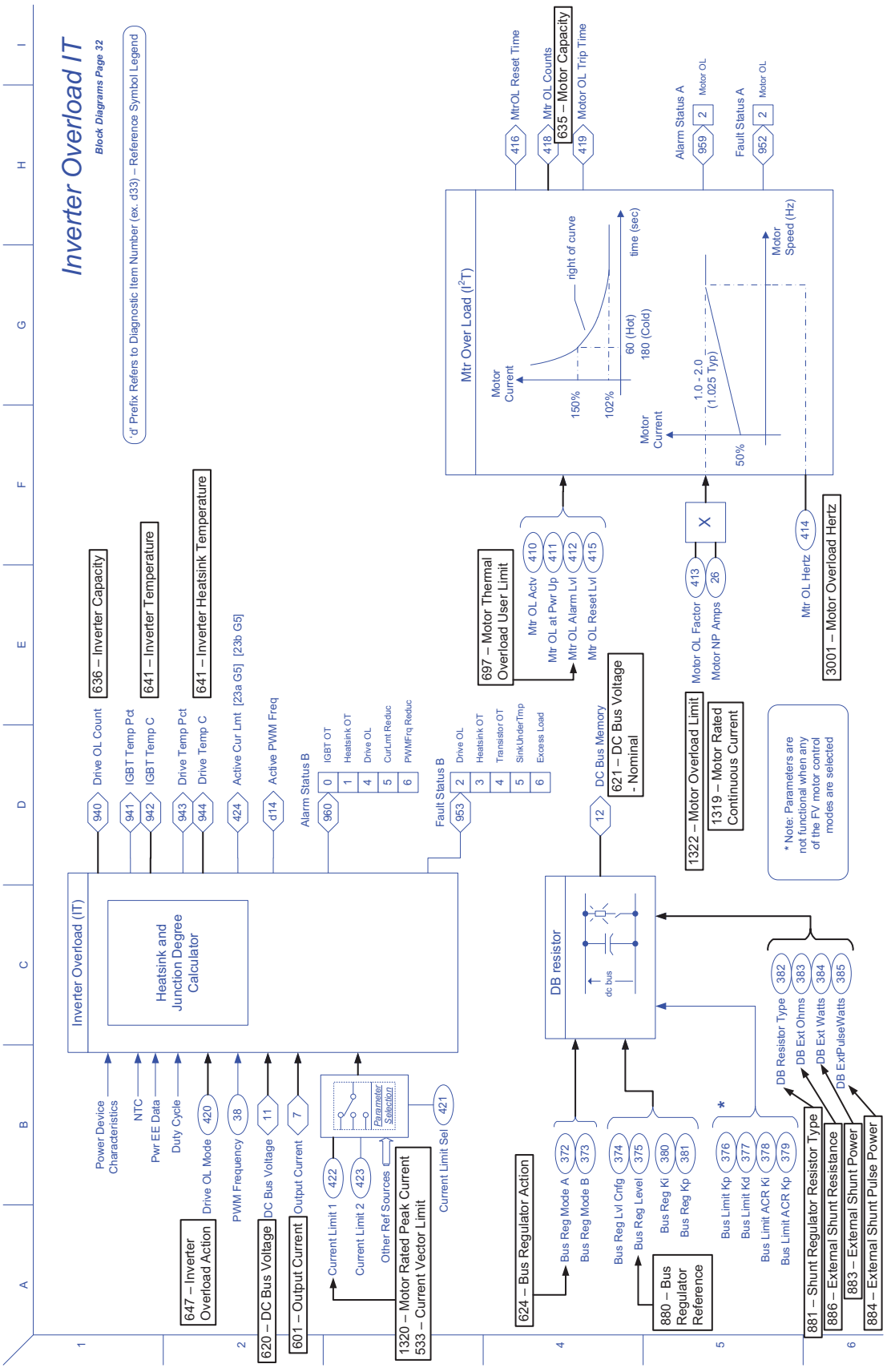
Inputs and Outputs - Analog



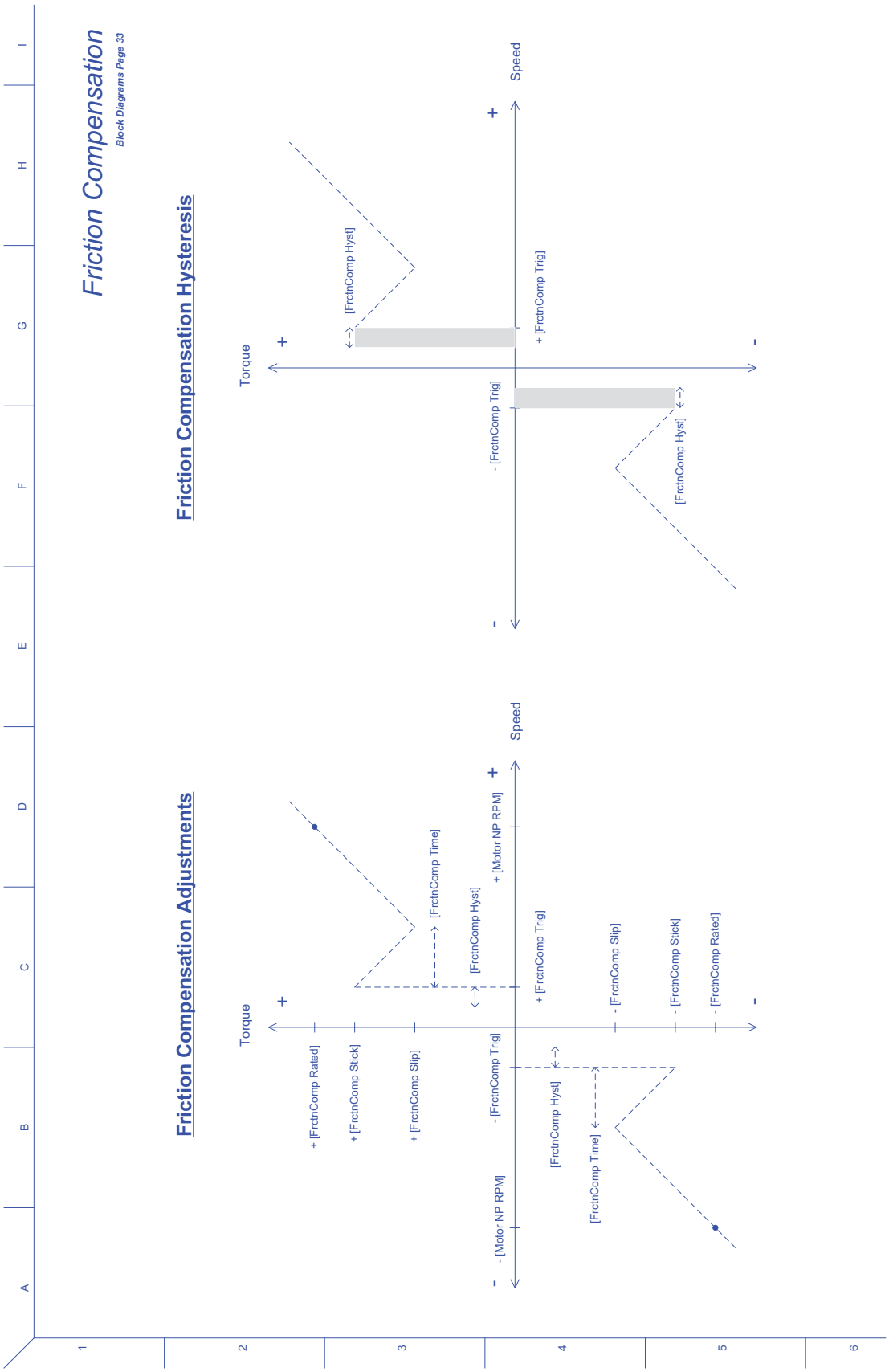
Control Logic



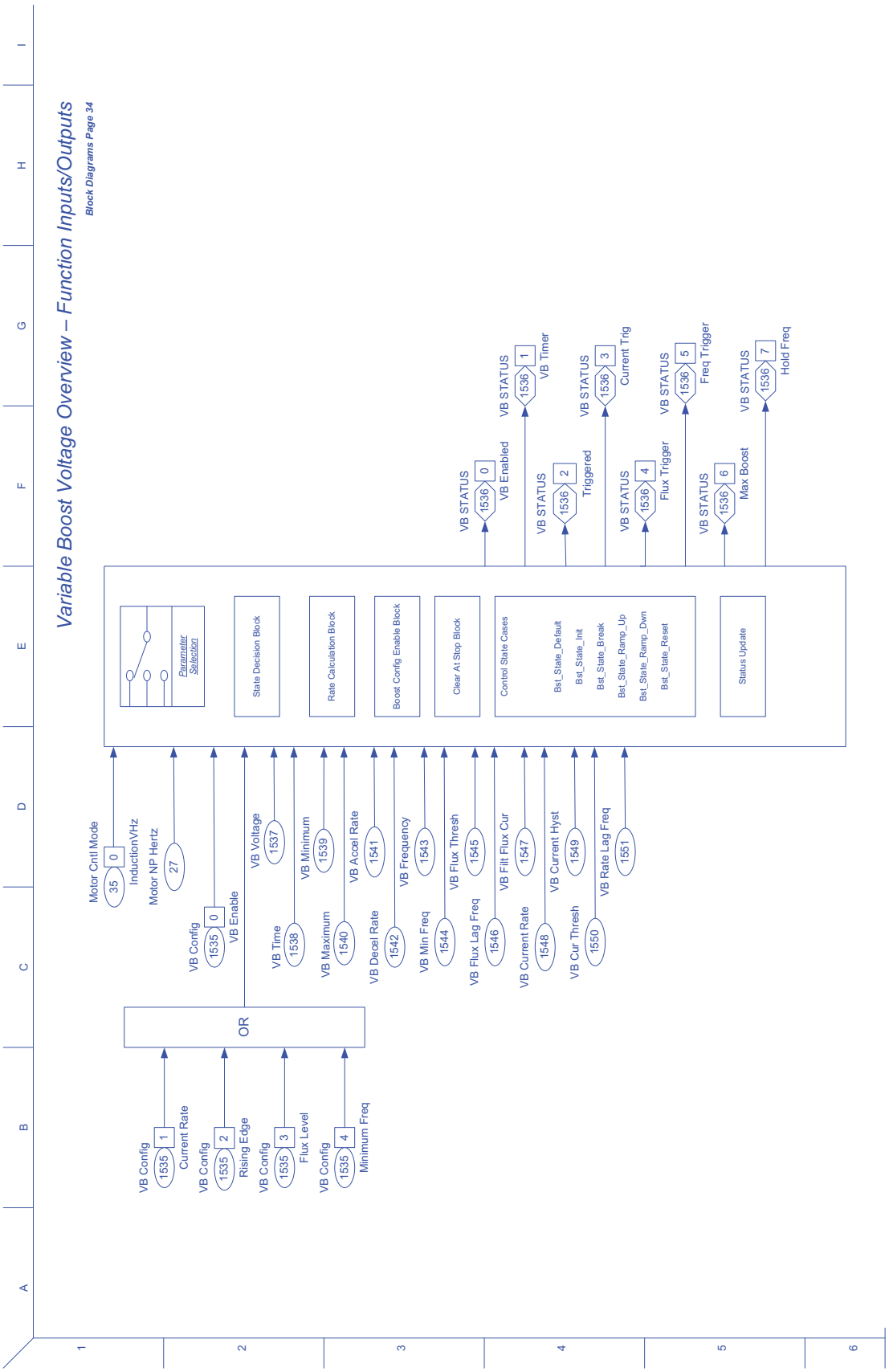
Inverter Overload IT


Inverter Overload IT
Block Diagrams Page 32
'd' Prefix Refers to Diagnostic Item Number (ex. d33) – Reference Symbol Legend
Inverter Overload (IT)
Heatsink and Junction Degree Calculator
Power Device Characteristics
NTC
Pwr EE Data
Duty Cycle
Drive OL Mode
PWM Frequency
DC Bus Voltage
Output Current
Current Limit 1
Current Limit 2
Other Ref Sources
Current Limit Sel
Parameter Selection
940 Drive OL Count
941 IGBT Temp Pct
942 IGBT Temp C
943 Drive Temp Pct
944 Drive Temp C
424 Active Cur Lmt [23a G5] [23b G5]
d14 Active PWM Freq
960 Alarm Status B
0 IGBT OT
1 Heatsink OT
4 Drive OL
5 CurLmt Reduc
6 PWMFrq Reduc
953 Fault Status B
2 Drive OL
3 Heatsink OT
4 Transistor OT
5 SinkUnderTmp
6 Excess Load
12 DC Bus Memory
636 – Inverter Capacity
641 – Inverter Temperature
641 – Inverter Heatsink Temperature
647 – Inverter Overload Action
620 – DC Bus Voltage
601 – Output Current
1320 – Motor Rated Peak Current
533 – Current Vector Limit
697 – Motor Thermal Overload User Limit
621 – DC Bus Voltage - Nominal
1322 – Motor Overload Limit
1319 – Motor Rated Continuous Current
3001 – Motor Overload Hertz
Mtr OL Actv 410
Mtr OL at Pwr Up 411
Mtr OL Alarm Lvl 412
Mtr OL Reset Lvl 415
Motor OL Factor 413
Motor NP Amps 26
Mtr OL Hertz 414
Mtr Over Load (I²T)
Motor Current
150%
102%
right of curve
time (sec)
60 (Hot)
180 (Cold)
1.0 - 2.0 (1.025 Typ)
50%
Motor Speed (Hz)
416 MtrOL Reset Time
418 Mtr OL Counts
419 Motor OL Trip Time
635 – Motor Capacity
Alarm Status A
959 2 Motor OL
Fault Status A
952 2 Motor OL
* Note: Parameters are not functional when any of the FV motor control modes are selected
DB resistor
dc bus
624 – Bus Regulator Action
Bus Reg Mode A 372
Bus Reg Mode B 373
Bus Reg Lvl Cnfg 374
Bus Reg Level 375
Bus Reg Ki 380
Bus Reg Kp 381
880 – Bus Regulator Reference
Bus Limit Kp 376
Bus Limit Kd 377
Bus Limit ACR Ki 378
Bus Limit ACR Kp 379
DB Resistor Type 382
DB Ext Ohms 383
DB Ext Watts 384
DB ExtPulseWatts 385
881 – Shunt Regulator Resistor Type
886 – External Shunt Resistance
883 – External Shunt Power
884 – External Shunt Pulse Power

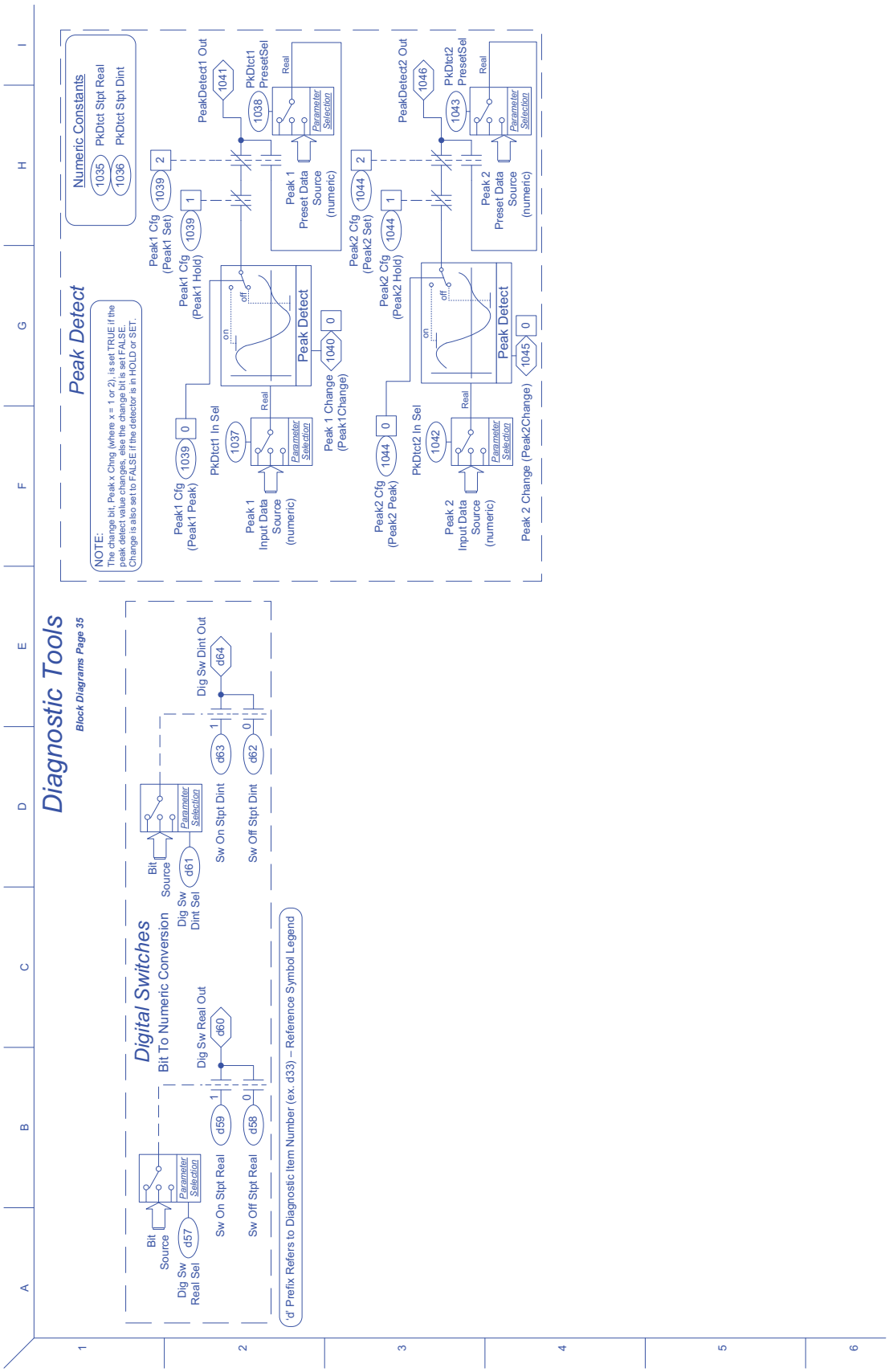
Friction Compensation



Variable Boost Voltage Overview – Function Inputs/Outputs



Diagnostic Tools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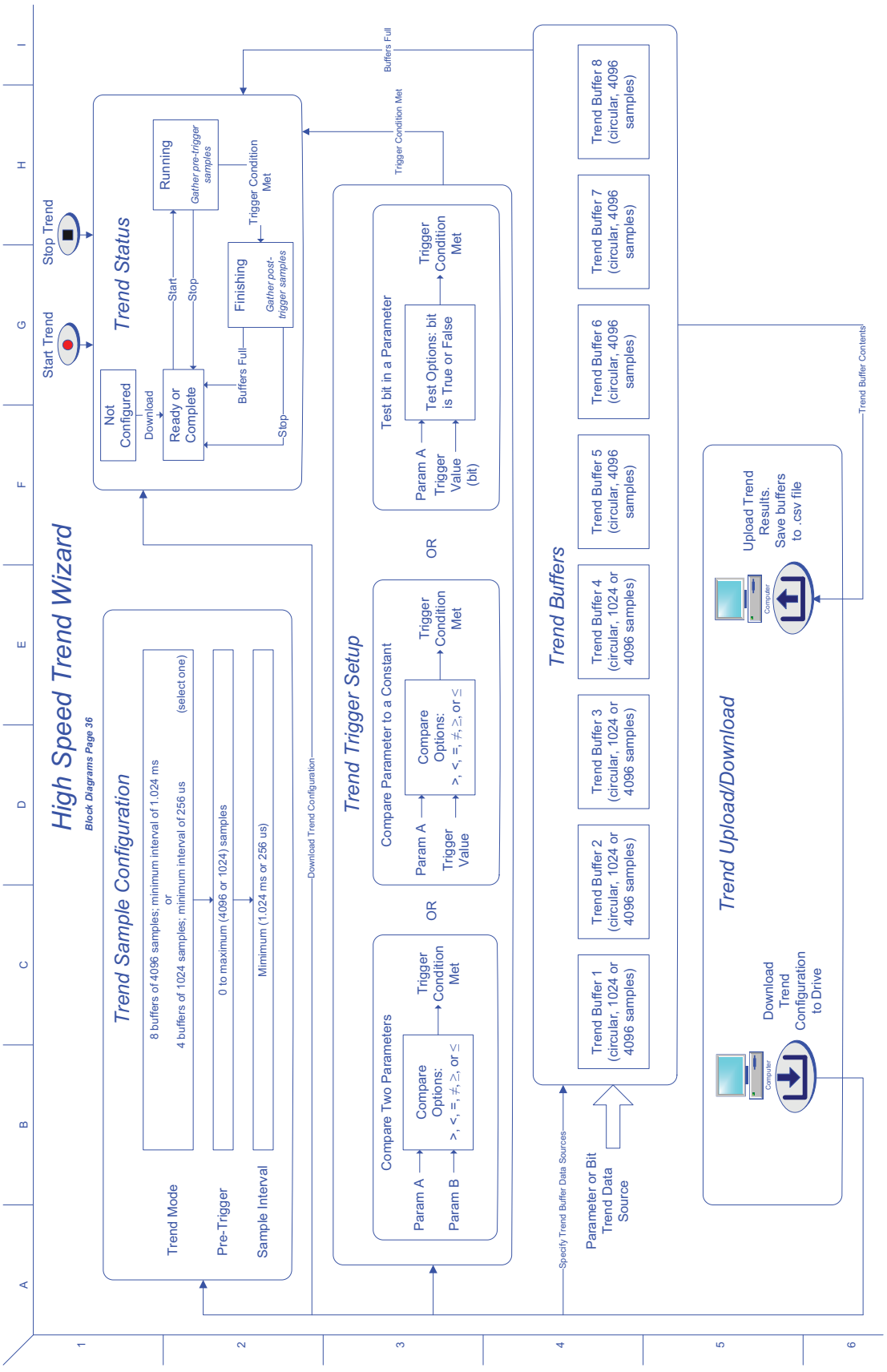
Digital Switches
Bit To Numeric Conversion
Dig Sw Real Sel
Bit Source
Parameter Selection
Sw On Stpt Real
Sw Off Stpt Real
Dig Sw Real Out
Dig Sw Dint Sel
Sw On Stpt Dint
Sw Off Stpt Dint
Dig Sw Dint Out
'd' Prefix Refers to Diagnostic Item Number (ex. d33) – Reference Symbol Legend
Peak Detect
NOTE:
The change bit, Peak x Chng (where x = 1 or 2), is set TRUE if the peak detect value changes, else the change bit is set FALSE. Change is also set to FALSE if the detector is in HOLD or SET.
Numeric Constants
PkDtct Stpt Real
PkDtct Stpt Dint
Peak1 Cfg (Peak1 Peak)
Peak1 Cfg (Peak1 Hold)
Peak1 Cfg (Peak1 Set)
PkDtct1 In Sel
Peak 1 Input Data Source (numeric)
Peak 1 Change (Peak1Change)
Peak 1 Preset Data Source (numeric)
PkDtct1 PresetSel
PeakDetect1 Out
Peak2 Cfg (Peak2 Peak)
Peak2 Cfg (Peak2 Hold)
Peak2 Cfg (Peak2 Set)
PkDtct2 In Sel
Peak 2 Input Data Source (numeric)
Peak 2 Change (Peak2Change)
Peak 2 Preset Data Source (numeric)
PkDtct2 PresetSel
PeakDetect2 Out
Peak Detect
on
off
Real

High Speed Trending Wizard



Notes:

PowerFlex 755 Standard and Safety Drive Module Optional Attributes

The following table specifies what optional attribute and corresponding control mode functionality is supported by a PowerFlex 755 drive module.

Y = The attribute/enum/bit is supported

N = The attribute/enum/bit is **not** supported

R = The attribute is required

RSLogix 5000 software Control Modes

- N = No Control Mode
- F = Frequency Control Mode
- P = Position Control Mode
- V = Velocity Control Mode
- T = Torque Control Mode

For more information on the Control Modes, see Integrated Motion on the Ethernet/IP Network Reference Manual, publication MOTION-RM003.

The Integrated Motion on the Ethernet/IP Network Reference Manual provides a programmer with details about the Integrated Motion on the Ethernet/IP Network Control Modes, Control Methods, and AXIS_CIP_DRIVE Attributes.

Table 25 - Conditional Implementation Key

Key	Description
AOP	Special device specific semantics needed from AOP
Co	Controller only attribute (controller attribute that resides only in controller)
C/D	Yes = The attribute is replicated in the drive
CScale	Motion Scaling Configuration set to Controller Scaling
Derived	Implementation rules follow another attribute
Dr	Drive replicated attribute (controller attribute that is replicated in drive)
Drive Scaling	Drive device supports drive scaling functionality
DScale	Motion Scaling Configuration set to Drive Scaling
E21	EnDat 2.1® (feedback type)
E22	EnDat 2.2® (feedback type)
E	Encoder-based control, a feedback device is present
!E	Encoderless or sensorless control, a feedback device in not present
HI	Hiperface® (feedback type)
IM	Rotary or Linear Induction Motor (motor type)

Table 25 - Conditional Implementation Key

Key	Description
Linear Absolute	Feedback Unit - meter; Feedback n Startup Method- absolute
Linear Motor	Linear PM motor or Linear Induction motor (motor type)
LT	LDT or Linear Displacement Transducer (feedback type)
NV	Motor NV or Drive NV (motor data source)
0-Bits	Optional bits associated with bit mapped attribute
0-Enum	Optional enumerations associated with attribute
PM	Rotary or Linear Permanent Magnet motor (motor type)
Rotary Absolute	Feedback Unit - rev; Feedback n Startup Method- absolute
Rotary Motor	Rotary PM motor or Rotary Induction motor (motor type)
SC	Sine/Cosine (feedback type)
SL	Stahl SSI (feedback type)
SS	SSI (feedback type)
TM	Tamagawa (feedback type)
TP	Digital Parallel (feedback type)
TT	Digital AqB (feedback type)

Table 26 - PowerFlex 755 Safety Drive Module Optional Attributes

ID	Access	Attribute	N	F	P	V	T	Conditional Implementation
19	Set	Axis Features	R	R	R	R	R	0-Bits 0 = Fine Interpolation (Y) 1 = Registration Auto-rearm (Y) 2 = Alarm Log (Y) 5 = Hookup Test (Y) 6 = Commutation Test (Y) 7 = Motor Test (Y) 8 = Inertia Test (Y) 9 = Sensorless Control (Y)
30	Set	Axis Configuration	R	R	R	R	R	0-Enum 0 = Feedback Only (N) 1 = Frequency Control (Y) 2 = Position Loop (Y) 3 = Velocity Loop (Y) 4 = Torque Loop (Y)
31	Set	Feedback Configuration	R	R	R	R	R	0-Enum 0 = No Feedback (V/Y)(T/Y) 3 = Load Feedback (PVT/N) 4 = Dual Feedback (P/Y) 8 = Dual Integrator Feedback (P/Y)
45	Set	Motion Scaling Configuration	R	R	R	R	R	0-Enum 1 = Drive Scaling (N)
1310/251	Set	Motor Catalog Number	-	N	N	N	N	Dr NV
1313	Set	Motor Data Source	-	R	R	R	R	0-Enum 1 = Database (Y) 2 = Drive NV (Y) 3 = Motor NV (N)

Table 26 - PowerFlex 755 Safety Drive Module Optional Attributes

ID	Access	Attribute	N	F	P	V	T	Conditional Implementation
1315	Set	Motor Type	-	R	R	R	R	0-Enum 1 = Rotary Permanent Magnet (Y) 2 = Rotary Induction (Y) 3 = Linear Permanent Magnet (N) 4 = Linear Induction (N)
1317	Set	Motor Polarity	-	Y	Y	Y	Y	
1320	Set	Motor Rated Peak Current	-	N	N	N	N	N-IM
1321	Set	Motor Rated Output Power	-	Y	Y	Y	Y	Y-IM
1322	Set	Motor Overload Limit	-	Y	Y	Y	Y	
1323	Set	Motor Integral Thermal Switch	-	N	N	N	N	
1324	Set	Motor Max Winding Temperature	-	N	N	N	N	
1325	Set	Motor Winding To Ambient Capacitance	-	N	N	N	N	
1326	Set	Motor Winding To Ambient Resistance	-	N	N	N	N	
2310	Set	PM Motor Flux Saturation	-	N	N	N	N	PM Motor only
1339	Set	PM Motor Rated Torque	-	N	N	N	N	Rotary PM Motor only
1340	Set	PM Motor Torque Constant	-	N	N	N	N	Rotary PM Motor only
1342	Set	PM Motor Rated Force	-	N	N	N	N	Rotary PM Motor only
1343	Set	PM Motor Force Constant	-	N	N	N	N	Rotary PM Motor only
1330	Set	Rotary Motor Inertia	-	N	Y	Y	N	Rotary Motor only
1332	Set	Rotary Motor Max Speed	-	N	N	N	N	Rotary Motor only
1333	Set	Rotary Motor Damping Coefficient	-	N	N	N	N	Rotary Motor only
2311	Set	Rotary Motor Fan Cooling Speed	-	N	N	N	N	Rotary Motor only
2312	Set	Rotary Motor Fan Cooling Derating	-	N	N	N	N	Rotary Motor only
1336	Set	Linear Motor Mass	-	N	N	N	N	Linear Motor only
1337	Set	Linear Motor Max Speed	-	N	N	N	N	Linear Motor only
1338	Set	Linear Motor Damping Coefficient	-	N	N	N	N	Linear Motor only
2313	Set	Linear Motor Integral Limit Switch	-	N	N	N	N	Linear Motor only
1349	Set	Induction Motor Magnetization Reactance	-	N	N	N	N	Ind Motor only
1350	Set	Induction Motor Rotor Resistance	-	N	N	N	N	Ind Motor only
1352	Set	Induction Motor Rated Slip Speed	-	Y	Y	Y	N	Ind Motor only
1370	Set	Load Type	N	N	N	N	N	DScale
1371	Set	Transmission Ratio Input	N	N	N	N	N	DScale
1372	Set	Transmission Ratio Output	N	N	N	N	N	DScale
1373	Set	Actuator Type	N	N	N	N	N	DScale
1374	Set	Actuator Lead	N	N	N	N	N	DScale
1375	Set	Actuator Lead Unit	N	N	N	N	N	DScale
1376	Set	Actuator Diameter	N	N	N	N	N	DScale
1377	Set	Actuator Diameter Unit	N	N	N	N	N	DScale
44	Set	Feedback Unit Ratio	-	-	Y	N	-	
1401	Get	Feedback 1 Serial Number	N	-	N	N	N	

Table 26 - PowerFlex 755 Safety Drive Module Optional Attributes

ID	Access	Attribute	N	F	P	V	T	Conditional Implementation
1414	Set	Feedback 1 Polarity	Y	-	Y	Y	Y	
1415	Set	Feedback 1 Startup Method	R	-	R	R	R	0-Enum 1= Absolute (Y)
1420	Set	Feedback 1 Data Length	Y	-	Y	Y	Y	TP,SS
1421	Set	Feedback 1 Data Code	Y	-	Y	Y	Y	TP,SS
1422	Set	Feedback 1 Resolver Transformer Ratio	N	-	N	N	N	RS
1423	Set	Feedback 1 Resolver Excitation Voltage	N	-	N	N	N	RS
1424	Set	Feedback 1 Resolver Excitation Frequency	N	-	N	N	N	RS
1425	Set	Feedback 1 Resolver Cable Balance	N	-	N	N	N	RS
2400	Set	Feedback 1 Loss Action	N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
2403	Set	Feedback 1 Velocity Filter Taps	Y	-	Y	Y	Y	
2404	Set	Feedback 1 Accel Filter Taps	N	-	N	N	N	
1434	Set	Feedback 1 Velocity Filter Bandwidth	Y	-	Y	Y	Y	
1435	Set	Feedback 1 Accel Filter Bandwidth	Y	-	Y	Y	Y	
2405	Set	Feedback 1 Battery Absolute	N	-	N	N	N	TM
1451	Get	Feedback 2 Serial Number	N	-	N	N	N	
1464	Set	Feedback 2 Polarity	Y	-	Y	Y	Y	
1465	Set	Feedback 2 Startup Method	R	-	R	R	R	0-Enum 1 = Absolute (Y)
1470	Set	Feedback 2 Data Length	Y	-	Y	Y	Y	TP,SS
1471	Set	Feedback 2 Data Code	Y	-	Y	Y	Y	TP,SS
1472	Set	Feedback 2 Resolver Transformer Ratio	N	-	N	N	N	RS
1473	Set	Feedback 2 Resolver Excitation Voltage	N	-	N	N	N	RS
1474	Set	Feedback 2 Resolver Excitation Frequency	N	-	N	N	N	RS
1475	Set	Feedback 2 Resolver Cable Balance	N	-	N	N	N	RS
2450	Set	Feedback 2 Loss Action	N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
2453	Set	Feedback 2 Velocity Filter Taps	N	-	N	N	N	
2454	Set	Feedback 2 Accel Filter Taps	N	-	N	N	N	
1484	Set	Feedback 2 Velocity Filter Bandwidth	N	-	N	N	N	
1485	Set	Feedback 2 Accel Filter Bandwidth	N	-	N	N	N	
2455	Set	Feedback 2 Battery Absolute	N	-	N	N	N	TM
365	Get	Position Fine Command	-	-	Y	-	-	
366	Get	Velocity Fine Command	-	-	Y	Y	-	
367	Get	Acceleration Fine Command	-	-	N	N	N	
370	Set	Skip Speed 1	-	Y	-	-	-	
371	Set	Skip Speed 2	-	Y	-	-	-	
372	Set	Skip Speed 3	-	Y	-	-	-	

Table 26 - PowerFlex 755 Safety Drive Module Optional Attributes

ID	Access	Attribute	N	F	P	V	T	Conditional Implementation
373	Set	Skip Speed Band	-	Y	-	-	-	
374	Set*	Ramp Velocity - Positive	-	Y	-	Y	-	Derived
375	Set*	Ramp Velocity - Negative	-	Y	-	Y	-	Derived
376	Set*	Ramp Acceleration	-	Y	-	Y	-	Derived
377	Set*	Ramp Deceleration	-	Y	-	Y	-	Derived
378	Set	Ramp Jerk Control	-	Y	-	Y	-	
380	Set	Flying Start Enable	-	Y	-	Y	-	
445	Set	Position Error Tolerance Time	-	-	Y	-	-	
781	Set	Position Lead Lag Filter Bandwidth	-	-	Y	-	-	
782	Set	Position Lead Lag Filter Gain	-	-	Y	-	-	
783	Set	Position Notch Filter Frequency	-	-	Y	-	-	
446	Set	Position Integrator Control	-	-	R	-	-	0-Bits 1: Auto-Preset (N)
447	Set	Position Integrator Preload	-	-	N	-	-	
790	Set	Velocity Negative Feedforward Gain	-	-	Y	Y	-	
464/321	Set	Velocity Droop	-	Y	Y	Y	-	
465	Set	Velocity Error Tolerance	-	-	N	N	-	
466	Set	Velocity Error Tolerance Time	-	-	N	N	-	
467	Set	Velocity Integrator Control	-	-	R	R	-	0-Bits 1: Auto-Preset (N)
468	Set	Velocity Integrator Preload	-	-	Y	Y	-	
469	Set	Velocity Low Pass Filter Bandwidth	-	-	Y	Y	-	
470/327	Set	Velocity Threshold	N	Y	Y	Y	N	
471	Set	Velocity Lock Tolerance	-	Y	Y	Y	-	
473/325	Set	Velocity Limit - Positive	-	Y	Y	Y	-	
474/326	Set	Velocity Limit - Negative	-	Y	Y	Y	-	
833	Set	SLAT Configuration	-	-	-	Y	-	
834	Set	SLAT Set Point	-	-	-	Y	-	
835	Set	SLAT Time Delay	-	-	-	Y	-	
481	Set	Acceleration Trim	-	-	N	N	N	
482	Get	Acceleration Reference	-	-	N	N	N	
801	Get	Load Observer Acceleration Estimate	-	-	Y	Y	N	
802	Get	Load Observer Torque Estimate	-	-	Y	Y	N	
805	Set	Load Observer Configuration	-	-	Y	Y	N	0-Enum 1= Load Observer Only (Y) 2 = Load Observer with Velocity Estimate (N) 3 = Velocity Estimate Only (N) 4 = Acceleration Feedback (Y)
806	Set	Load Observer Bandwidth	-	-	Y	Y	N	
807	Set	Load Observer Integrator Bandwidth	-	-	N	N	N	
809	Set	Load Observer Feedback Gain	-	-	Y	Y	N	

Table 26 - PowerFlex 755 Safety Drive Module Optional Attributes

ID	Access	Attribute	N	F	P	V	T	Conditional Implementation
485	Set	Acceleration Limit	-	N	N	N	N	
486	Set	Deceleration Limit	-	N	N	N	N	
496	Set	System Inertia	-	-	R	R	N	
825	Set	Backlash Compensation Window	-	-	N	-	-	
498	Set	Friction Compensation Sliding	-	-	N	N	N	
499	Set	Friction Compensation Static	-	-	N	N	N	
500	Set	Friction Compensation Viscous	-	-	N	N	N	
826/421	Set	Friction Compensation Window	-	-	N	-	-	
827	Set	Torque Lead Lag Filter Bandwidth	-	-	Y	Y	N	
828	Set	Torque Lead Lag Filter Gain	-	-	Y	Y	N	
502	Set	Torque Low Pass Filter Bandwidth	-	-	N	N	N	
503	Set	Torque Notch Filter Frequency	-	-	Y	Y	Y	
506	Set	Torque Rate Limit	-	-	N	N	N	
507/334	Set	Torque Threshold	-	-	N	N	N	
508	Set	Overtorque Limit	-	Y	Y	Y	Y	
509	Set	Overtorque Limit Time	-	Y	Y	Y	Y	
510	Set	Undertorque Limit	-	Y	Y	Y	Y	
511	Set	Undertorque Limit Time	-	Y	Y	Y	Y	
521	Get	Operative Current Limit	-	-	N	N	N	
522	Get	Current Limit Source	-	-	N	N	N	
524	Get	Current Reference	-	-	N	N	N	
525	Get	Flux Current Reference	-	-	N	N	N	
840	Set	Current Disturbance	-	-	N	N	N	
527	Get	Current Error	-	-	N	N	N	
528	Get	Flux Current Error	-	-	N	N	N	
529	Get	Current Feedback	-	-	Y	Y	Y	
530	Get	Flux Current Feedback	-	-	Y	Y	Y	
553	Set	Current Vector Limit	-	Y	N	N	N	
554	Set	Torque Loop Bandwidth	-	-	N	N	N	
555	Set	Torque Integral Time Constant	-	-	N	N	N	
556	Set	Flux Loop Bandwidth	-	-	N	N	N	
557	Set	Flux Integral Time Constant	-	-	N	N	N	
558	Set	Flux Up Control	-	Y	Y	Y	Y	Ind Motor only 0-Enum 1 = Manual Delay (Y) 2 = Automatic Delay (Y)
559	Set	Flux Up Time	-	Y	Y	Y	Y	Ind Motor only
562	Set	Commutation Self-Sensing Current	-	-	N	N	N	PM Motor only 0-Value = #
563	Set	Commutation Polarity	-	-	N	N	N	PM Motor only

Table 26 - PowerFlex 755 Safety Drive Module Optional Attributes

ID	Access	Attribute	N	F	P	V	T	Conditional Implementation
250	Set	Feedback Commutation Aligned	-	-	Y	Y	Y	0-Enum 2 = Motor Offset (N) 3 = Self-Sense (Y)
570	Set	Frequency Control Method	-	R	-	-	-	0-Enum 128 = Fan/Pump Volts/Hertz (Y) 129 = Sensorless Vector (Y) 130 = Sensorless Vector Economy (Y)
600	Get	Output Frequency	-	R	Y	Y	Y	
610	Set	Stopping Action	-	R	R	R	R	0-Enum 2 = Ramped Decel Disable (FPV/Y) 3 = Current Decel Hold (PV/N) 4 = Ramped Decel Hold (PV/Y) 128 = DC Injection Brake (IM/Y) 129 = AC Injection Brake (IM/Y)
612	Set	Stopping Time Limit	-	-	N	N	N	
613/354	Set	Resistive Brake Contact Delay	-	N	N	N	N	PM Motor only
614	Set	Mechanical Brake Control	-	N	N	N	N	
615	Set	Mechanical Brake Release Delay	-	N	N	N	N	
616	Set	Mechanical Brake Engage Delay	-	N	N	N	N	
870	Set	DC Injection Brake Current	-	Y	Y	Y	Y	Ind Motor only
872	Set	DC Injection Brake Time	-	Y	Y	Y	Y	Ind Motor only
871	Set	Flux Braking Enable	-	Y	Y	Y	Y	Ind Motor only
627	Set	Power Loss Action	-	Y	Y	Y	Y	0-Enum 2 = Decel Regen (Y)
628	Set	Power Loss Threshold	-	Y	Y	Y	Y	
629	Set	Shutdown Action	-	N	N	N	N	0-Enum 1 = Drop DC Bus (N)
630	Set	Power Loss Time	-	Y	Y	Y	Y	
637	Get	Converter Capacity	-	N	N	N	N	
638/262	Get	Bus Regulator Capacity	-	N	N	N	N	
646	Set	Motor Overload Action	-	N	N	N	N	0-Enum 1 = Current Foldback (N)
647	Set	Inverter Overload Action	-	Y	Y	Y	Y	0-Enum 1 = Current Foldback (Y) 128 = Reduce PWM Rate (Y) 129 = PWM Foldback (Y)
659	Get	CIP Axis Alarms	Y	Y	Y	Y	Y	
904	Get	CIP Axis Alarms - RA	Y	Y	Y	Y	Y	
695	Set	Motor Overspeed User Limit	-	Y	Y	Y	Y	
697	Set	Motor Thermal Overload User Limit	-	Y	Y	Y	Y	
699	Set	Inverter Thermal Overload User Limit	-	N	N	N	N	
706	Set	Feedback Noise User Limit	N	N	N	N	N	
707	Set	Feedback Signal Loss User Limit	N	N	N	N	N	
708	Set	Feedback Data Loss User Limit	N	N	N	N	N	

Table 26 - PowerFlex 755 Safety Drive Module Optional Attributes

ID	Access	Attribute	N	F	P	V	T	Conditional Implementation
730	Get	Digital Inputs	-	Y	Y	Y	Y	
731	Set	Digital Outputs	-	N	N	N	N	
732/267	Get	Analog Input 1	-	N	N	N	N	
733/268	Get	Analog Input 2	-	N	N	N	N	
734	Set	Analog Output 1	-	N	N	N	N	
735	Set	Analog Output 2	-	N	N	N	N	
750	Set	Local Control	N	N	N	N	N	0-Enum 1 = Conditionally Allowed (N) 2 = Allowed (N)
980/242	Get	Guard Status	-	Y	Y	Y	Y	
981/243	Get	Guard Faults	-	Y	Y	Y	Y	

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